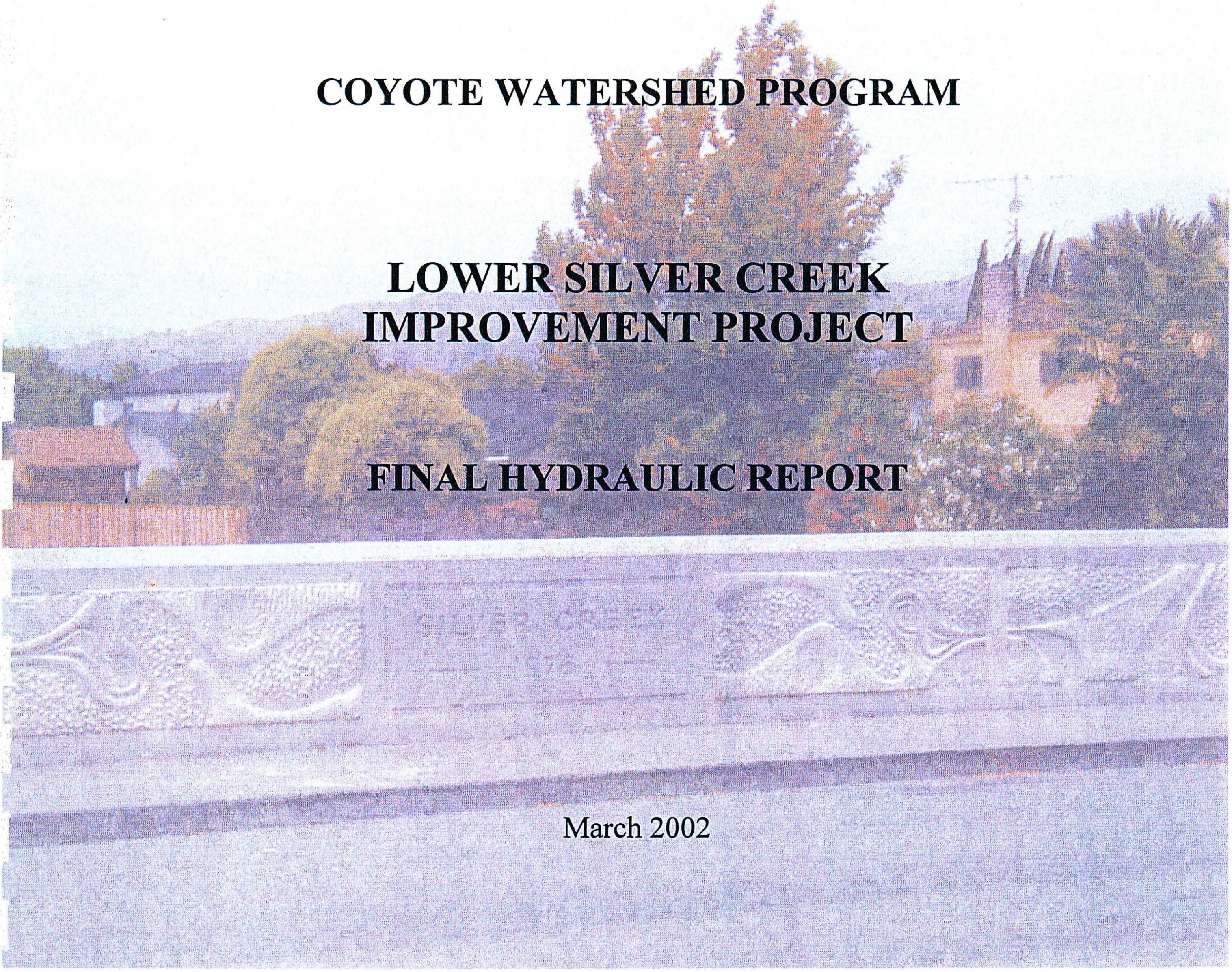
Santa Clara Valley Water District



COYOTE WATERSHED PROGRAM

LOWER SILVER CREEK IMPROVEMENT PROJECT

FINAL HYDRAULIC REPORT

March 2002

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COYOTE WATERSHED PROGRAM
LOWER SILVER CREEK RESTORATION PROJECT
FINAL HYDRAULIC REPORT

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CHAPTER 1
OVERVIEW

The Lower Silver Creek Improvement Project Hydraulic Report has been prepared for the Coyote Watershed Program to document preliminary hydraulic and sediment transport analyses. This work is intended to confirm the feasibility of the National Resources Conservation Service (NRCS) planning study, and to serve as overall guidance during design of the channel improvement plans. Upon completion of those plans, design features should be checked against the content of this report for consistency. The Coyote Watershed Program operates under the auspices of the Santa Clara Valley Water District. This report is written to provide engineering guidance during design. It is assumed that the reader is familiar with the engineering concepts discussed herein.

PROJECT OBJECTIVES

The basic objective of the Lower Silver Creek Reaches 1-6 Improvement Project is to provide a level of flood protection along Lower Silver Creek consistent with (NRCS) and Santa Clara Valley Water District (District) policies, and the policies of the Federal Emergency Management Agency (FEMA) as administered through the National Flood Insurance Program (NFIP). District and NFIP regulations define the "base flood" as a flood having a one percent chance of being equaled or exceeded in any given year.

Although the primary project objective is to provide a level of flood protection along Lower Silver Creek meeting District, NRCS and FEMA standards, additional project objectives include:

- balancing flood reduction with environmental restoration, community beautification, and recreational opportunities.
- providing efficient and cost-effective flood control maintenance to ensure that the District is able to maintain design system performance in the future;
- allowing for more natural geomorphic processes in Lower Silver Creek; and
- engendering community support for the proposed project.

SCOPE OF HYDRAULIC REPORT

Within this hydraulic report, design one-percent discharges are estimated using a watershed model built under the direction of the District. Discharges for other return periods of interest are also calculated. Lake Cunningham is examined as a flood control facility, and conceptual modifications are proposed to help reduce the downstream discharge without placing permanent park facilities at jeopardy.

Steady-state backwater and forewater analyses have been made to evaluate proposed channel improvements over a range of possible roughness conditions. Hydraulic stability is addressed, and the process of selecting bridges for replacement is documented.

Finally preliminary sediment transport analyses have been made to assess the potential for long-term channel stability, potential sediment accumulations, and the need for bank slope protection.

BACKGROUND

Lower Silver Creek flows generally northward from Silver Creek Road at Barberry Lane to Coyote Creek in east San Jose. The creek drains about 15 percent of the Coyote Creek watershed at the confluence. Nearly one-half of the creek's drainage basins are tributary to Lake Cunningham, with the remainder influent to the creek downstream of Cunningham Avenue. This hydraulic report includes an evaluation of the hydrologic and hydraulic regime within the Lower Silver Creek watershed from Lake Cunningham to Coyote Creek.

Historic Flooding

Recorded flooding problems within the Lower Silver Creek watershed include runoff events in December 1889, January and March 1911, January 1952, December 1955, April 1958, January 1963, February 1983, and March 1983. During the February 1998 El Niño, the creek was flowing bank-full downstream of Lake Cunningham, although no overtopping was witnessed.

Flood Insurance Requirements

In its current state, Lower Silver Creek cannot contain estimated one-percent flood discharges within its banks. Residents in adjoining neighborhoods must purchase federally sponsored flood insurance to carry a mortgage. Since Lower Silver Creek was excavated through a broad alluvial plain, when floodwaters leave its banks, they generally flow away from the channel as shallow sheet flow. Urbanization has tended to concentrate the flow of floodwater within street rights-of-way.

CREEK RESTORATION PROJECT ELEMENTS

In 1998, the NRCS prepared a set of conceptual drawings for the Lower Silver Creek Improvement Project. The NRCS only performed preliminary hydraulic calculations using methods that did not factor in backwater effects from Coyote Creek or other channel transitions. No water surface profiles or hydraulic models are available to the District for verification of the NRCS plan. No analyses were performed at existing bridges, although the bridge at Jackson Avenue was proposed for replacement.

Channel Improvements

The Program has since refined and enhanced the original NRCS plan to reduce the amount of concrete lining, utilize more natural and environmentally sensitive materials and configurations, provide for more natural channel geomorphologic processes, improve maintenance, and allow greater public access to the creek. As a result, the channel configuration has been revised in a few reaches, including the acquisition of additional rights-of-way to facilitate the channel enhancements. This report is based upon a model developed with channel geometry available to Schaaf & Wheeler in December 2001.

Lake Cunningham Modifications

The NRCS based its conceptual channel improvements for Lower Silver Creek on a set of discharge values of unknown origin that are within ten percent of earlier base flood flow estimates made by the Santa Clara Valley Water District. Within the District's hydrologic model, HEC-1 storage routing routines are used to account for attenuation provided by Lake Cunningham, which reduces large-event flows downstream of Cunningham Avenue. The intent of this work is to reconfirm the performance of Lake Cunningham, and propose feasible operating modifications that can minimize downstream one-percent design discharge, while providing for the safe storage of excess runoff volume in a reasonable fashion to which the City of San Jose can agree.

Hydraulic Performance

Proposed modifications at Lake Cunningham would reduce the design discharges in Lower Silver Creek by up to twenty percent. Channel improvements will enable the one-percent water surface profile to be carried at or below the natural bank elevation throughout most of the project reach. To meet FEMA and NRCS freeboard criteria, some reaches require additional protection in the form of floodwalls. The length of wall height in excess of three feet is very limited.

The hydraulic analyses contained herein indicate that the following bridges or culverts require replacement or modification so that the enhanced NRCS plan can work without excessively high floodwalls. It may be noted, however, that the proposed enhancements to the NRCS plan have not, in and of themselves, caused the need for bridge replacement. The NRCS was also planning to modify the Jackson Avenue culvert.

Bridge Replacements or Modifications

Alum Rock Avenue

Sunset Avenue

Jackson Avenue

Capitol Expressway

Story Road

Cunningham Avenue

Sediment Transport

Within most of the project reach, the channel bottom will be unlined and subject to erosive velocity. Some of the eroded material will move downstream, and where channel velocity decreases, may accumulate as sediment deposits. Reaches 1 through 3 of Lower Silver Creek will be excavated through cohesive material such as clay, silty clay, and sandy clay; while the soils in Reaches 4 through 6 are clayey sands with gravel. Tractive force analyses show that *if vegetation does not become well established to provide erosion protection, both the channel bed and banks will be subject to erosive velocities and will scour in the design flood event*. Consequent deposition may be expected in channel reaches with lower flow velocities, particularly in backwater areas. Areas with potential for local deposition during extreme runoff events include the reach between Interstate 680 and Capitol Expressway, the Sunset Avenue culvert, the reach between McKee Road and Alum Rock Avenue, and the McKee Road culvert itself.

CHAPTER 2
PROJECT BACKGROUND

This chapter introduces the Lower Silver Creek study area, discusses the history of flood protection efforts within this part of east San Jose, summarizes previous project plans, and introduces the Program's project objectives.

WATERSHED DESCRIPTION

Lower Silver Creek flows generally northward from Silver Creek Road at Barberry Lane to Coyote Creek in east San Jose. The creek drains about 44 square miles of watershed, or roughly 15 percent of the 291 square miles tributary to Coyote Creek at the confluence (Figure 2-1). Major tributaries to Lower Silver Creek are listed in Table 2-1. Nearly one-half of the creek's drainage basins are tributary to Lake Cunningham, with the remainder influent to the creek downstream of Cunningham Avenue. This hydraulic report includes an evaluation of the entire hydrologic and hydraulic regime within the Lower Silver Creek watershed from Lake Cunningham to Coyote Creek, with the exception of detailed hydraulic analyses of tributaries.

Table 2-1: Lower Silver Creek Watershed

Drainage Area	Square miles
Direct Drainage to Lower Silver Creek	1.8
Thompson Creek	16.9
Norwood Creek	2.5
Ruby Creek	1.6
Flint Creek	2.0
(Total Tributary Watershed at Lake Cunningham)	**26.3**
South Babb Creek	3.7
North Babb Creek	2.8
Miguelita Creek	3.3
Direct Drainage to Lower Silver Creek	7.7
(Total Tributary Watershed at Coyote Creek)	**43.8**

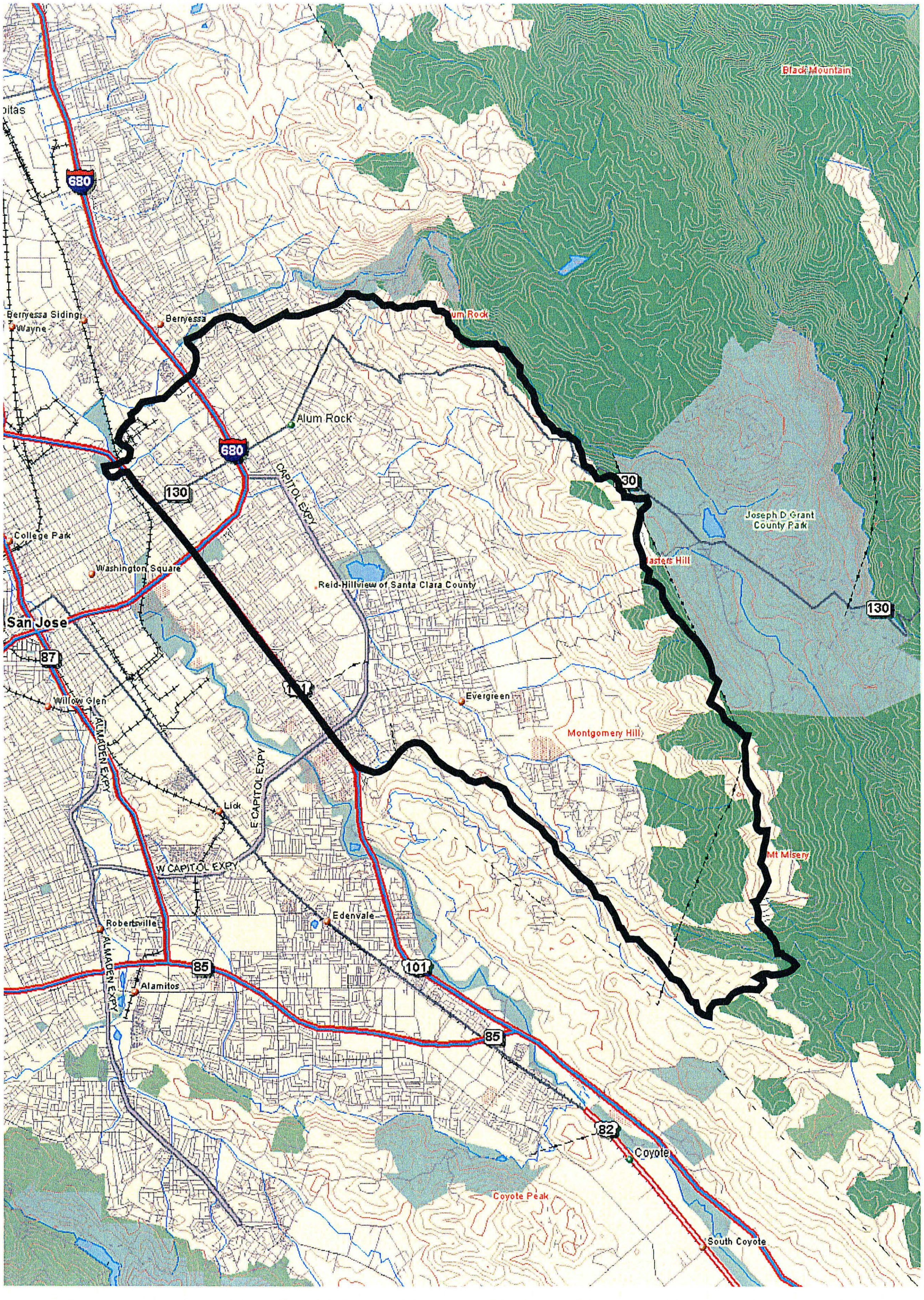

Figure 2-1. Lower Silver Creek Watershed

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GEOLOGICAL AND HYDROLOGIC SETTING

The study area sits atop broad alluvial fans that were formed as streams emerged from the eastern foothills onto the Santa Clara Valley floor and deposited unconsolidated materials as their slopes flattened. Streambed deposits and alluvial fans generally slope toward San Francisco Bay to the northwest. Fine sands, silts and clays characterize native soils underlying the area. Natural drainage and flooding tends to be as shallow sheet flow through much of the study area, with the predominant direction of flow to the north and west.

Identifying the proposed improvements as a "stream restoration project," is somewhat spurious. Historically the Silver Creek channel was generally undefined downstream of Lake Cunningham, as an examination of the 1899 USGS Quadrangle for the area reveals (Figure 2-2). A broad alluvial plain was formed downstream of a marsh located at present-day Cunningham Avenue. Frequent flooding would have been characterized by broad, shallow flow generally to the north and west toward Coyote Creek.

As the area developed for agricultural use, an incised channel was created to drain the marsh and contain the frequent flood flows. Silver Creek was later bifurcated into "upper" and "lower" segments to reduce flows in the lower reaches. Subsequent quadrangles show the drainage channel laid out for convenience rather than necessarily following the natural contours (Figure 2-3). As a result, the channel does not always run downhill. This situation creates significant challenges for the present project, since as one moves upstream, top of bank elevations do not increase commensurately with design water surface profiles. Containing flood discharges within the natural banks can therefore be rather difficult.

ENVIRONMENTAL SETTING

Lower Silver Creek and its tributaries flow through a mixture of land uses, from rural open space areas in the foothills, through lower-density hillside residential areas, and eventually through higher density urban areas of east San Jose.

Downstream of Lake Cunningham, Lower Silver Creek has been excavated within natural earth. Various forms of slope protection are provided, ranging from nearly bare vegetation, to more established vegetation, sacked concrete slope protection, and full concrete lining.

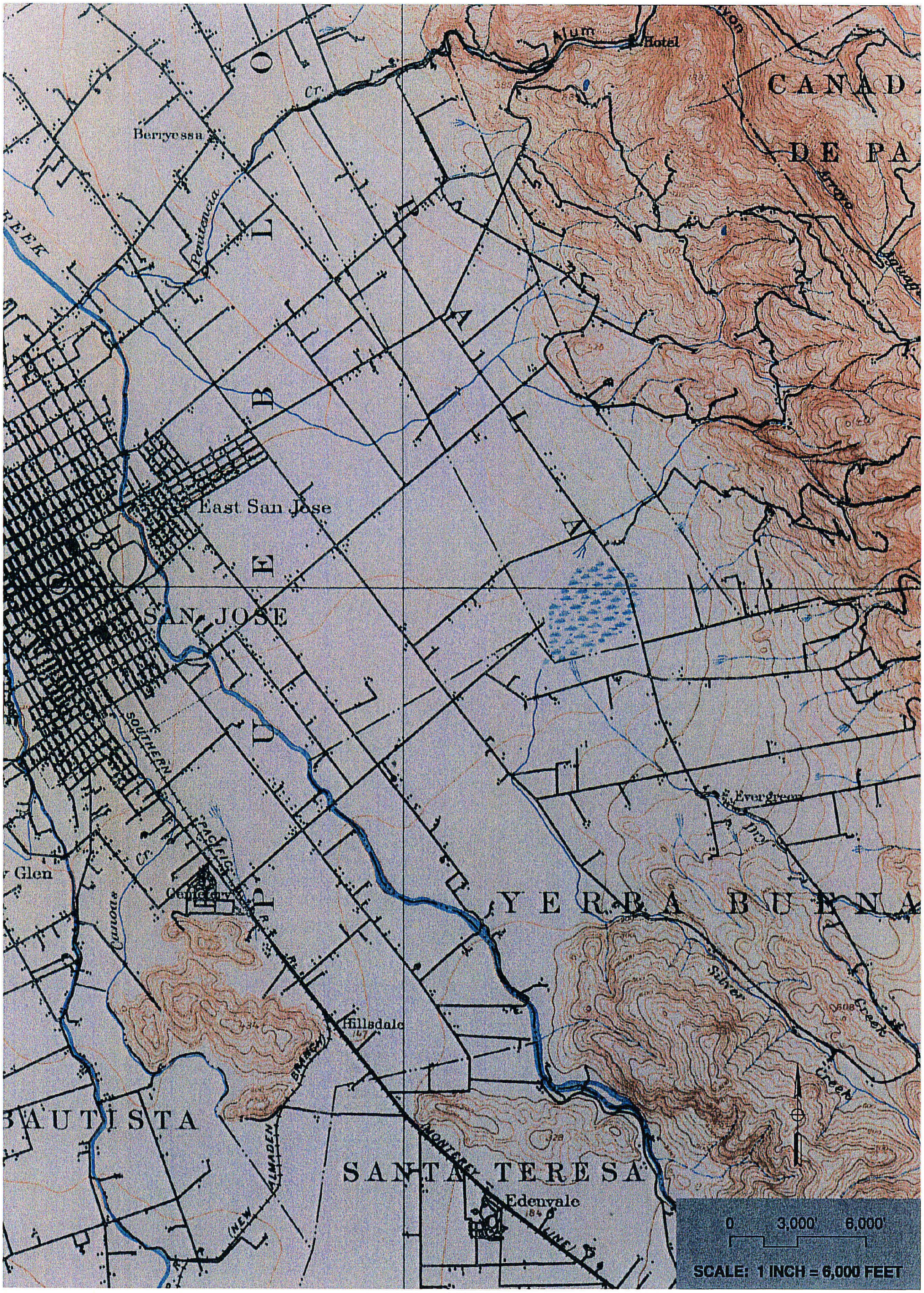

Figure 2-2. Portion of 1899 USGS San Jose Quadrangle

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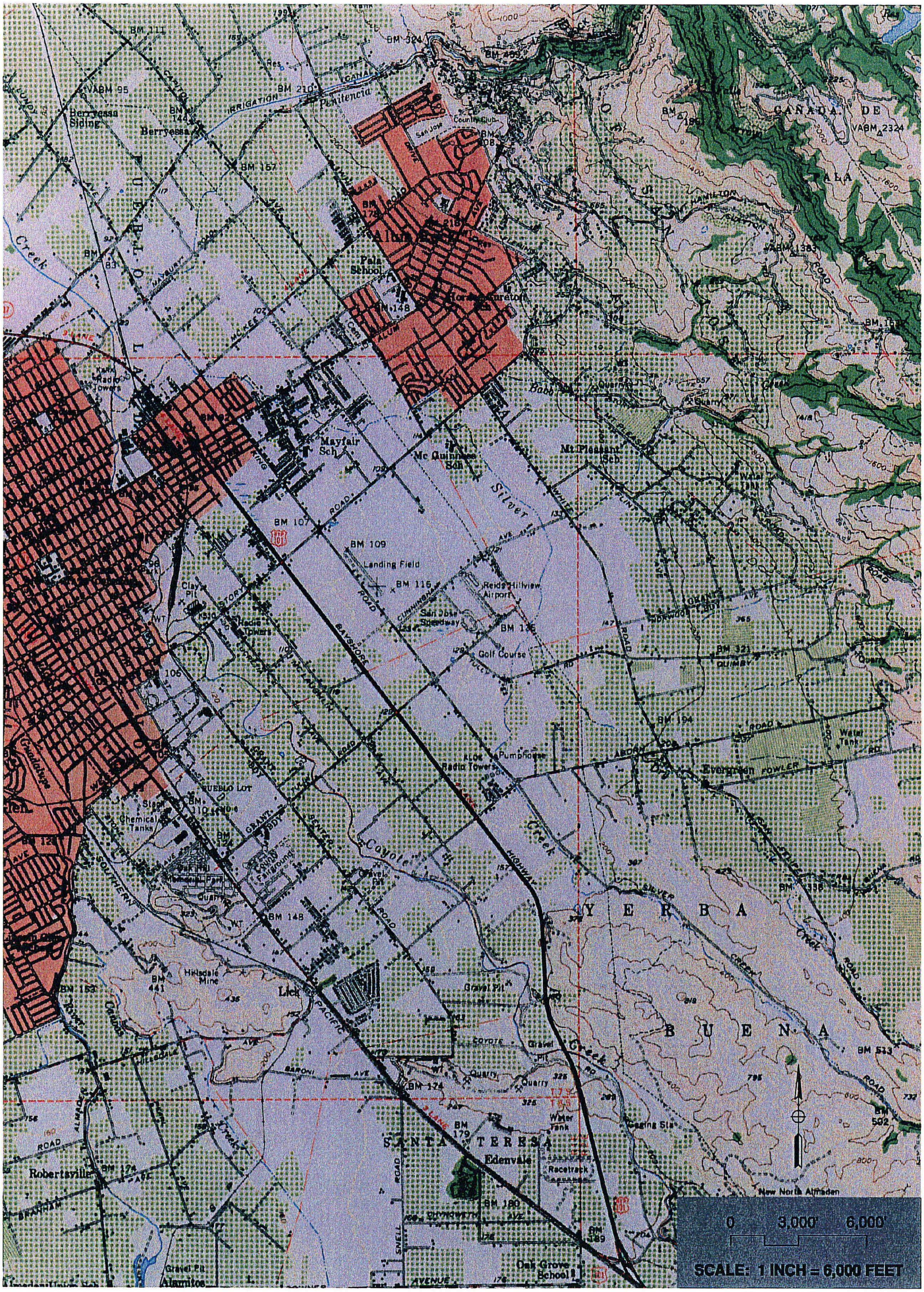

Figure 2-3. Portion of 1953 USGS San Jose Quadrangle

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For convenience, the Lower Silver Creek project area has been broken into six reaches, as shown on Figure 2-4 and summarized by Table 2-2. Photographs keyed to the table are presented on the following pages along with brief descriptions of the current environmental setting.

Table 2-2: Lower Silver Creek Reaches

Reach	Limits	Photo #s	Description of Existing Channel
1	Coyote Creek to Miguelita Creek	1 – 6	Excavated earth channel
2	Miguelita Creek to McKee Road	7	Excavated earth, concrete U-frame
3A	McKee Rd thru Plata Arroyo Park	8 – 13	Excavated earth channel
3B	U/S Plata Arroyo Park	14	Excavated trapezoidal channel
3C	D/S Lausett Avenue	15	Concrete-lined trapezoidal channel
3D	Lausett Ave. to San Antonio St.	16 – 18	Excavated trapezoidal channel
3E,F	San Antonio St. to Interstate 680	19 – 21	Excavated earth channel
4A	Interstate 680 to Jackson Avenue	22, 23	Concrete lined banks, earth bottom
4B,C	Jackson Ave. to North Babb Creek	24 – 26	Excavated trapezoidal channel
5	N. Babb Creek to South Babb Creek	27 – 29	Excavated trapezoidal channel
6	S. Babb Creek to Cunningham Ave.	30 – 32	Excavated trapezoidal channel

Channel photographs taken after the winter seasons of 2000 and 2001 provide a baseline indication of channel conditions including sediment transport and vegetal growth. Since the 2000-2001 winter season was fairly mild, observed channel conditions did not substantially change from one year to the next. Recent flood events occurred in February 1998 and February 2000 (the 1998 event was the flood of record in many South Bay locations). The following photographs represent recent channel conditions.

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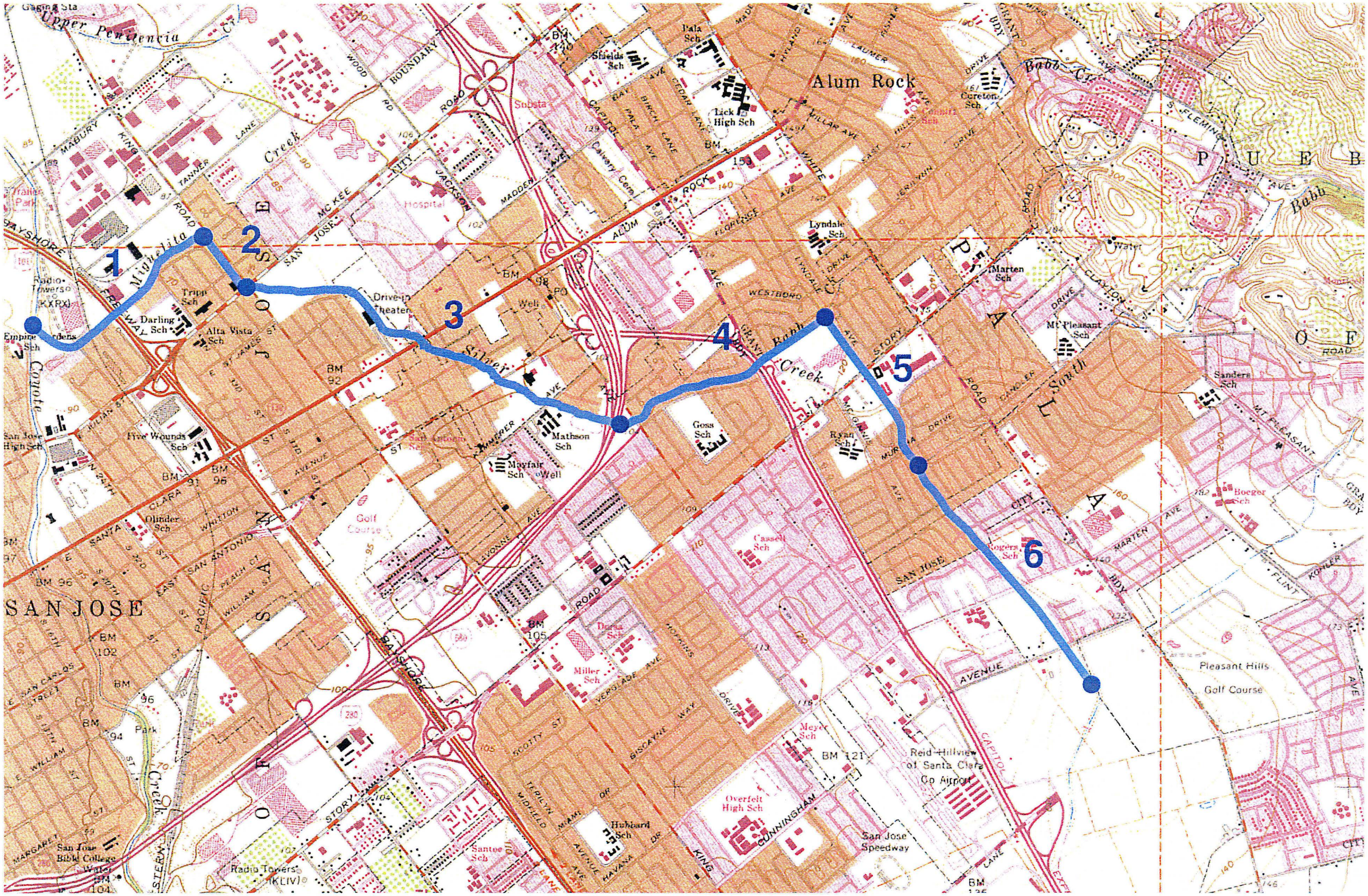


Figure 2-4. Reach Locations

Reach 1: Coyote Creek to Miguelita Creek

Within Reach 1, flow in Lower Silver Creek is influenced by backwater conditions in Coyote Creek. From the confluence upstream to Highway 101, Lower Silver Creek is situated in the regulatory one-percent floodplain that results from Coyote Creek overbanking to the south. It is essential that any proposed improvements on Lower Silver Creek do not impact the Coyote Creek floodplain.

Photo 1. Reach 1 Near Confluence: From the confluence with Coyote Creek to the Wooster Avenue Bridge, creek banks are lined in places with riprap and sacked concrete. Brush and tall trees line the upper banks. At the base of the banks grow tall reeds, with open water from toe to toe. →

Photo 2. Wooster Avenue Bridge: At the Wooster Avenue Bridge, short grasses and some brush cover the banks. Here the width of open water narrows; in some locations reeds have grown all the way across the bed. Bridge abutments and piers have been scoured by creek head-cutting.

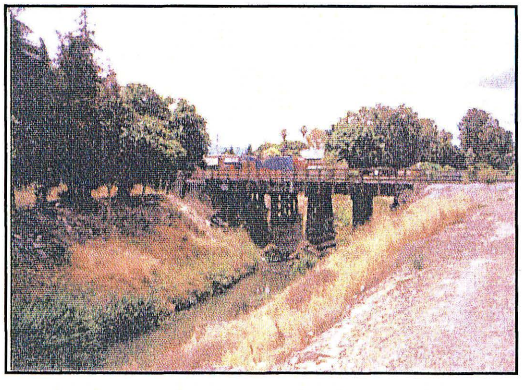
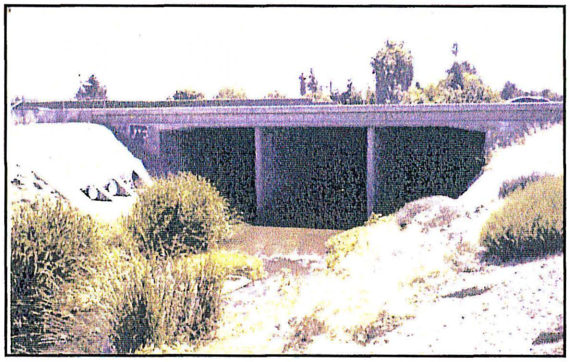
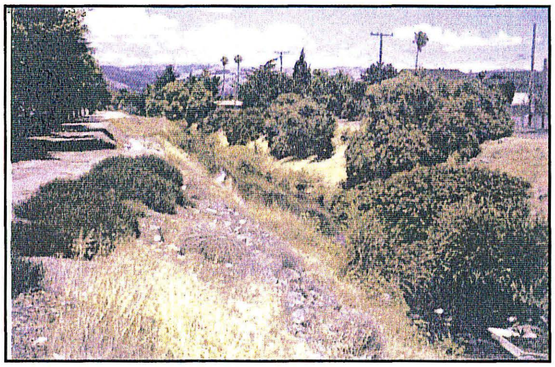


Photo 3. WPRR Bridge: At the railroad, the channel appears to be relatively clean and stable. Accumulations of debris are evidenced on each trestle bent.

Photo 4. Reach 1 D/S Highway 101: This channel reach is uniform and clean, with grass lining the north bank and large shade trees along the top of the south bank. The creek invert is characterized primarily by open water with some vegetation just above the toes. Just below the Highway 101 Bridge, reeds, cattails and other brush increase to cover the creek bed. →





Photos 5 and 6. Reach 1 from Highway 101 to Miguelita Creek: Some vegetation has been established in the sediment upstream of the bridge. Bank vegetation is in the form of short grass and sparse brush.

Reach 2: Miguelita Creek to McKee Road

Beginning at the confluence with Miguelita Creek, Lower Silver Creek parallels King Road as an excavated channel, generally trapezoidal in section, but with some sloughing of the easterly bank. A new bridge has been built to connect King Road with the Walgreen's shopping plaza. From this location to the McKee Road culvert, vertical channel walls have been constructed. The channel bottom is also concrete-lined for about 100 feet downstream of the McKee Road culvert.

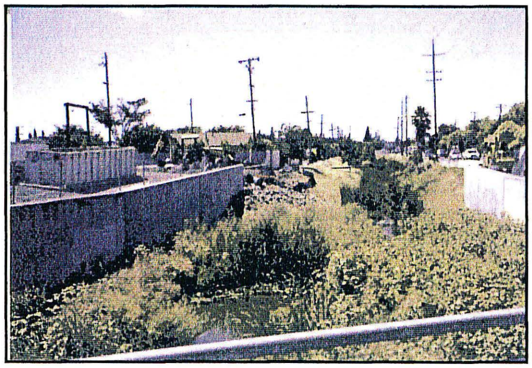
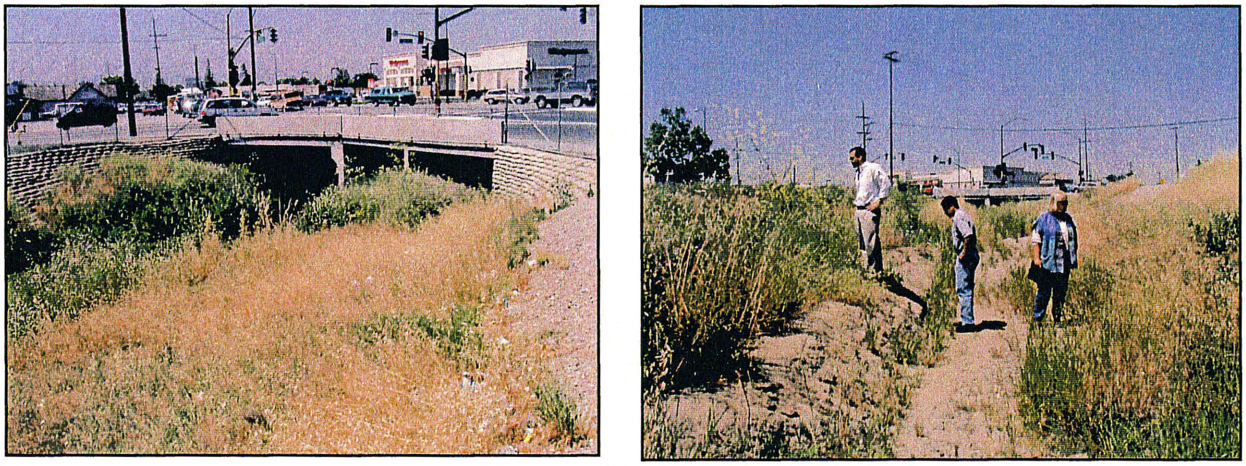


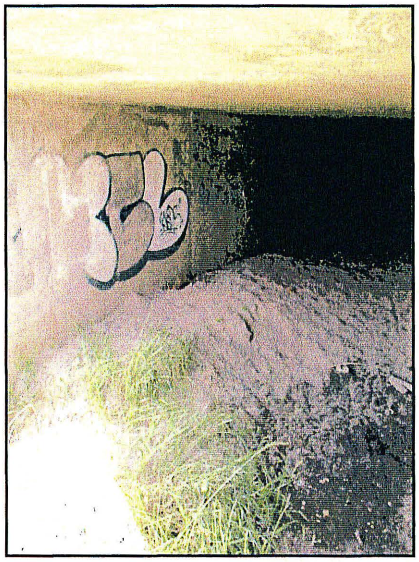
Photo 7. Reach 2 downstream of McKee Road: Just downstream of the triple box culvert, about two-thirds of the creek bed is covered with tall grasses, brush and reeds that have been established in sediment that has deposited on the concrete channel bottom. This condition is likely to continue in the future, so this reach will require periodic vegetation and sediment removal. The photograph was taken prior to the completion of the Walgreens Shopping Center Bridge.

Reach 3: McKee Road to Interstate 680

This is the most varied reach in terms of channel configuration. From McKee Road through the Plata Arroyo Park (Reach 3A), the channel is excavated from native materials with substantial creek and bank vegetation. An earthen levee provides flood protection to residents on the east bank, while the park itself floods during significant runoff events. Above the park, the trapezoidal channel is concrete lined upstream almost to San Antonio Street. The excavated channel is more natural as it passes Mayfair Park and Mathson Junior High before ending at Interstate 680.



Photos 8, 9. U/S Face of McKee/King Culvert: Note sediment deposits immediately upstream of bridge.



←Photo 10. Sediment Inside Eastern McKee Road Culvert Barrel.

Photo 11. Reach 3A (July 2000)

Photo 12. Reach 3A (May 2001)

Photo 13. End Reach 3A

Photo 14. Reach 3B→

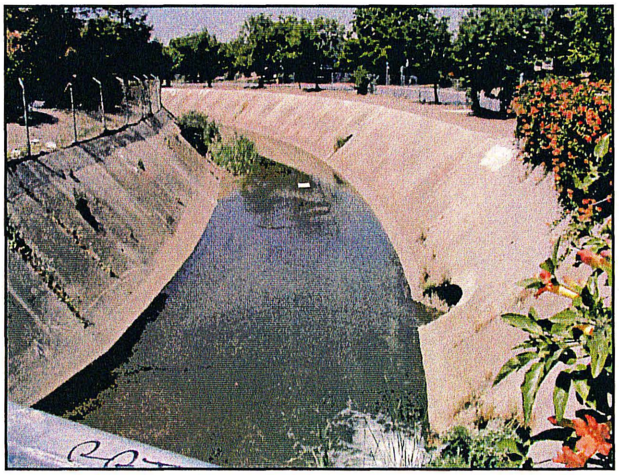


Photo 15. Reach 3C: Trapezoidal lining will be eliminated in much of this reach.

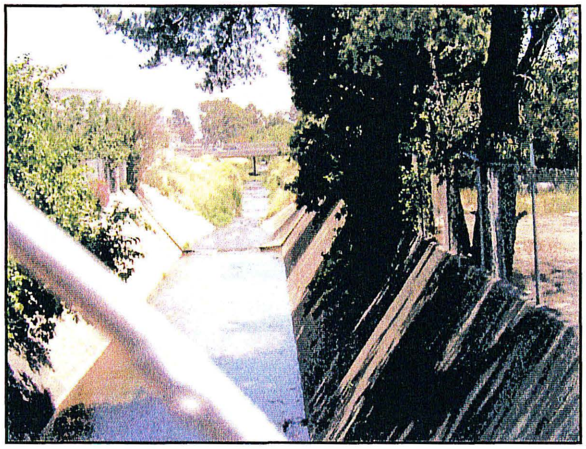


Photo 16. Reach 3D: Downstream of San Antonio

Photo 17. San Antonio Street: Downstream Face of Bridge, which will remain intact.↓

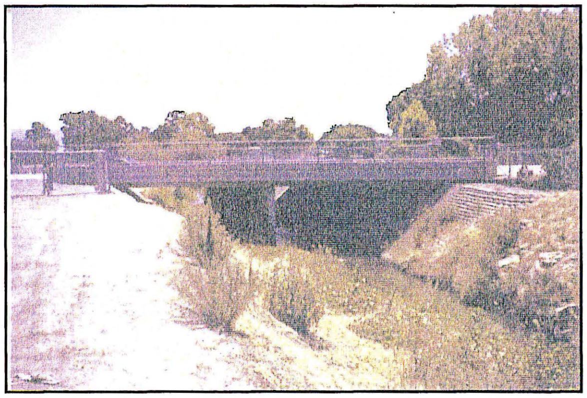


Photo 18. Reach 3D: US from San Antonio Bridge.

Photo 19. Reach 3E: Lower Silver Creek taken from Kammerer Bridge looking DS in Mayfair Park→

Photo 20. Reach 3F: From I680 (below)
Photo 21. Reach 3F: From Kammerer (below, right)

Reach 4. Interstate 680 to North Babb Creek

Above Interstate 680, Lower Silver Creek flows in a relatively uniform, clean, straight trapezoidal channel. Between the freeway and Jackson Avenue, the channel slopes are lined with concrete. Sediment accumulates within the nearly dead flat reach of creek between the 680 culvert and Jackson Avenue Bridge, particularly along the inside of the sweeping bend. From Jackson Avenue to Capitol Expressway, channel slopes are covered with short grasses, and there is some emergent wetland vegetation. Between Capitol and North Babb Creek, the channel is not quite as uniform, with some sloughing of the banks, and the available right-of-way diminishes from 90 feet to 65 feet.

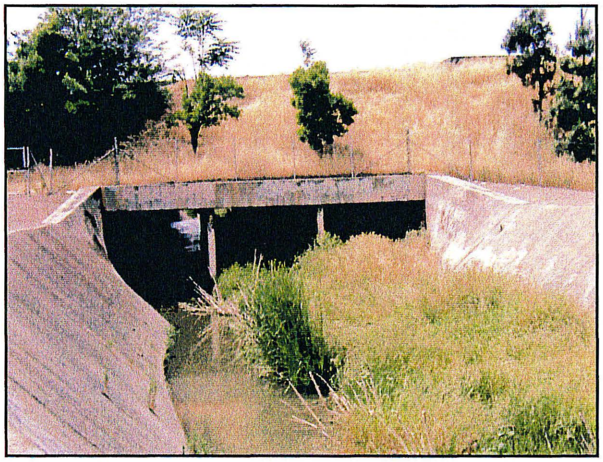
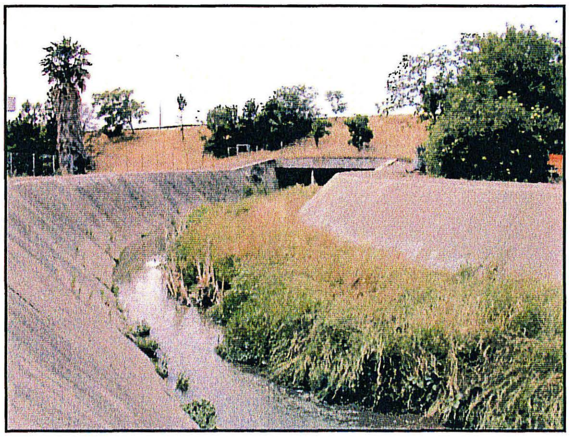


Photo 22. Reach 4A: Upstream Face of Interstate 680 Bridge

Photo 23. Reach 4A: From Jackson Avenue Bridge. Note sediment deposition on inside bend between Jackson Avenue and the freeway. This channel reach will continue to require regular vegetation and sediment removal.→



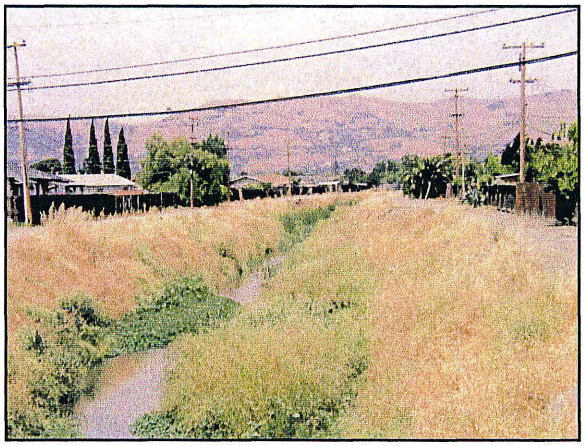
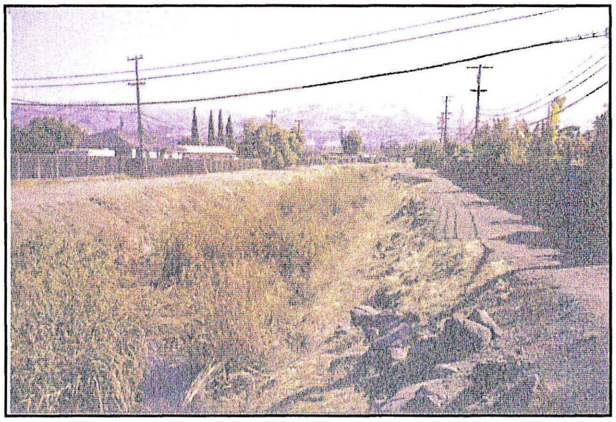


Photo 24. Reach 4B: From Jackson Ave Bridge (6/01). Note that bank grass is longer than one year earlier as shown in Photo 25.

Photo 25. Same View of Reach 4b (August 2000) Note sparser bank vegetation but taller emergent wetland vegetation. →



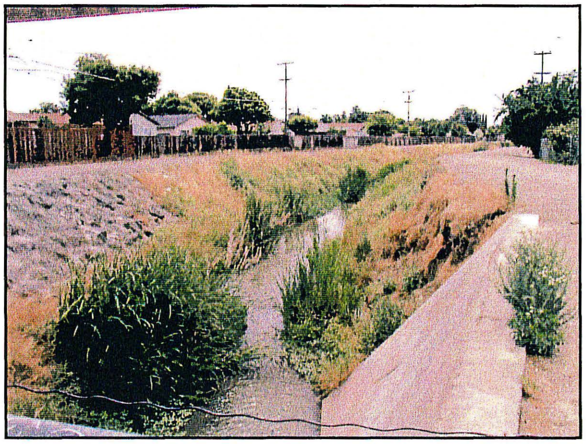


Photo 26. Reach 4B: From Capitol Expressway.

Reaches 5 and 6. North Babb Creek to Lake Cunningham

Similar in nature to Reach 4, Reaches 5 and 6 of Lower Silver Creek are also excavated trapezoidal channels, albeit with more generous rights-of-way than the upper part of Reach 4. High groundwater elevations in the vicinity appear to cause year-round standing water, particularly further upstream. The two tributaries in this reach deliver sediment into Lower Silver Creek. South Babb Creek appears to have conveyed significant volumes of sediment in the recent past.

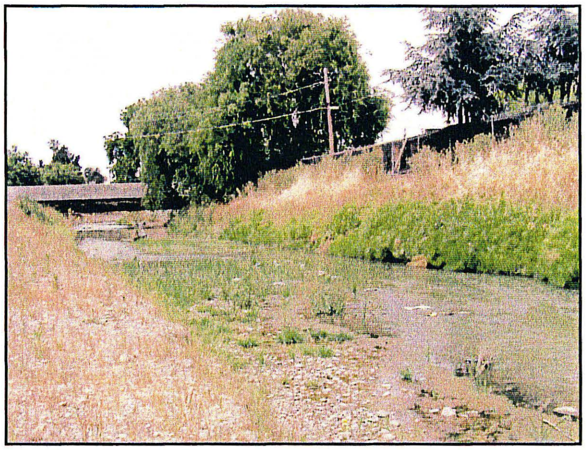
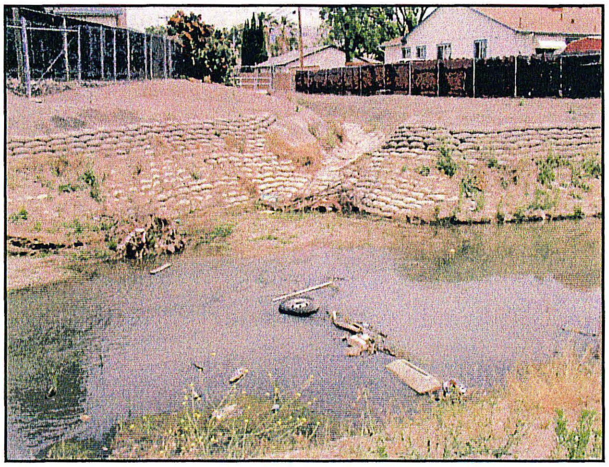


Photo 27. Reach 5 Above Murtha Drive: Note sediment deposition from South Babb Creek in June 2001. In the fall of 2000, sediment was removed from the confluence of South Babb Creek with Lower Silver Creek.

Photo 28. Reach 5 at South Babb Confluence: Note relative lack of sediment and standing water at the time of photography in June 2001. This photograph was taken after sediment removal was conducted by the District in the fall of 2000 →



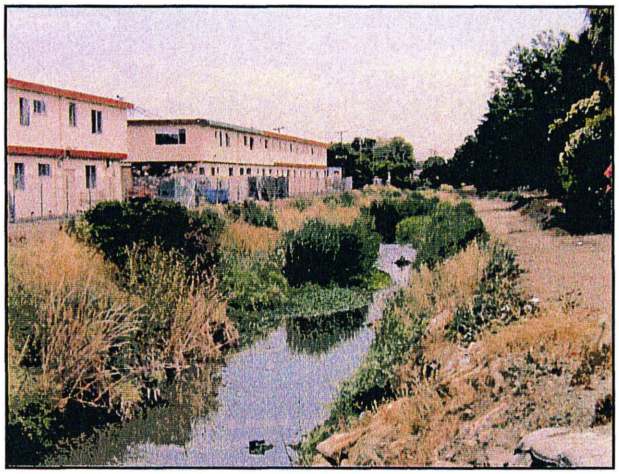
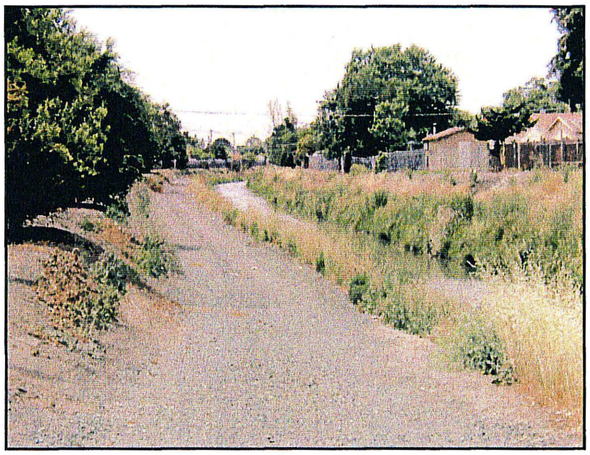


Photo 29. Reach 5 Upstream of Story Road.

Photo 30. Reach 6A D/S Moss Point Road.→



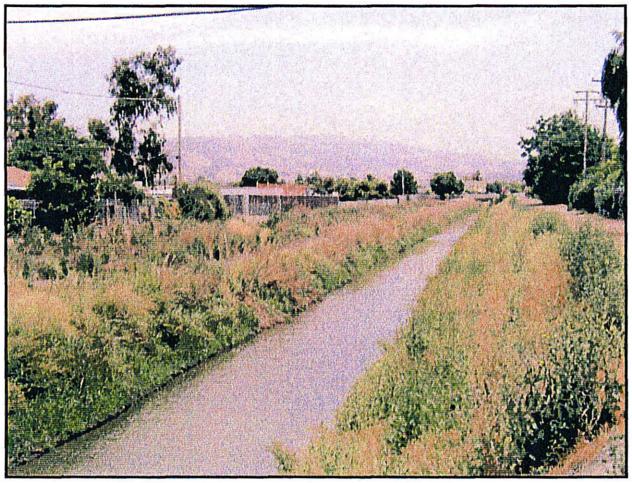
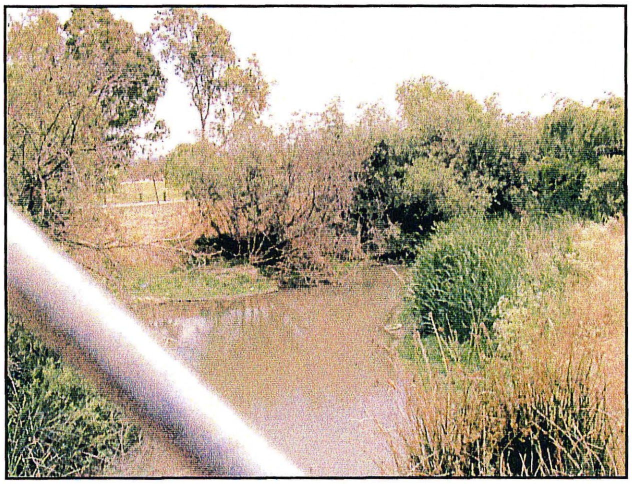


Photo 31. Reach 6B D/S Cunningham Avenue.

Photo 32. This view, looking upstream from the Cunningham Avenue Bridge, shows banks lined with dense brush and short grass. Reeds and brush also grow within the channel bed. In the distance is the levee bordering Lake Cunningham Park. Note the standing water, believed to be the groundwater table.→



FLOODING WITHIN THE WATERSHED

Recorded flooding problems within the Lower Silver Creek watershed include runoff events in December 1889, January and March 1911, January 1952, December 1955, April 1958, January 1963, February 1983, and March 1983. (FEMA, 1986.) During the February 1998 El Niño, the creek was flowing bank-full downstream of Lake Cunningham, although no overtopping was witnessed (personal observation).

Flood Protection Projects

Flood damages experienced during the 1950s led to a series of flood protection projects intended to increase the capacity of Lower Silver Creek. Table 2-3 lists those projects and their approximate date of construction.

Table 2-3: Past Flood Protection Projects

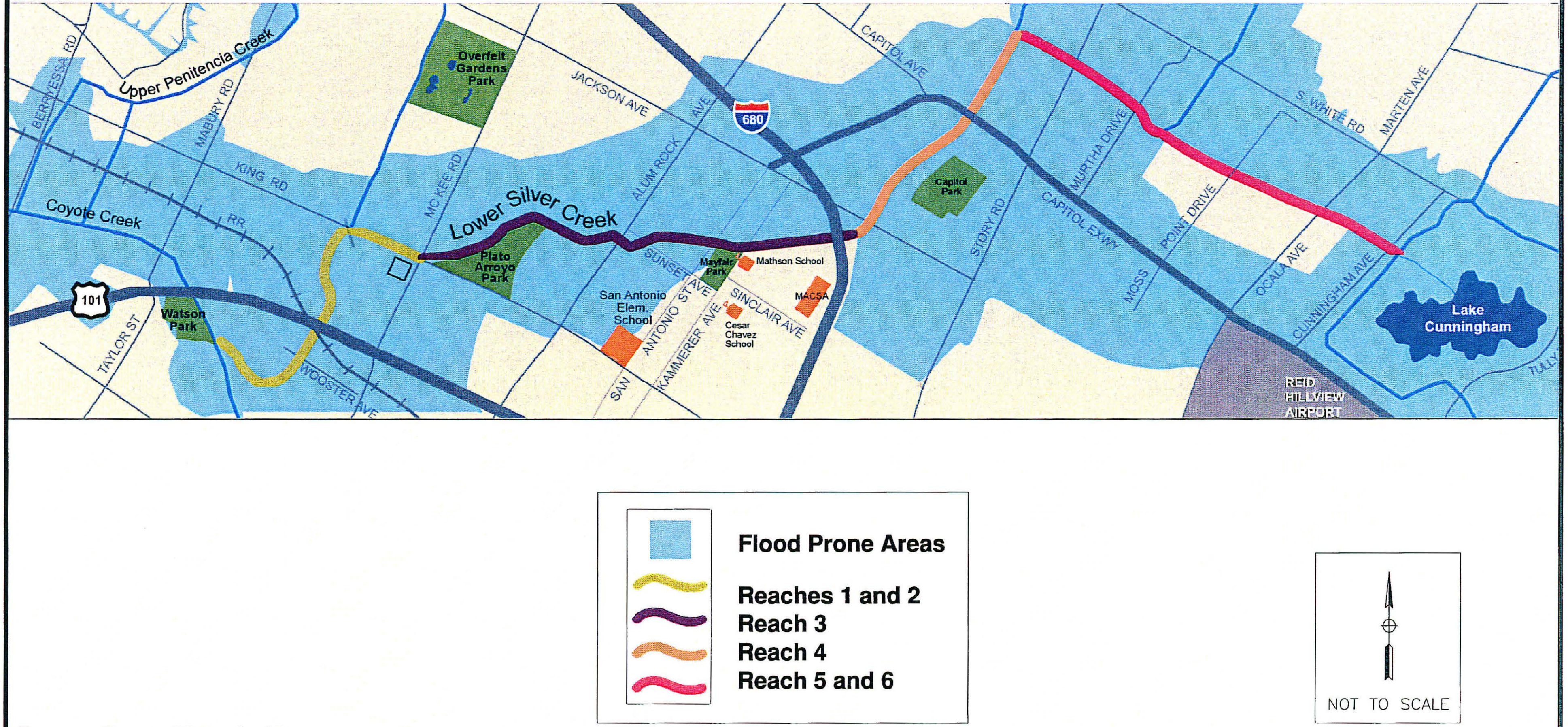
Year	Description
1950	McKee Road Culvert Replacement
1955	Capitol Avenue Culvert Extension
1958	Channel Excavation from McKee Road to Kammerer Avenue
1958	New Culverts at Alum Rock Avenue and Sunset Avenue
1961	Jackson Avenue Culvert Replacement
1971	Interstate 680 Culvert and Moss Point Drive Bridge
1972	Channel Excavation and Bank Protection from Capitol to Murtha
1973	Capitol Expressway Culvert Replacement
1974	San Antonio Street Bridge Replacement
1976	Channel Lining and Maintenance Road from Capitol to Cunningham
1976	New Bridges at Murtha Drive, Ocala Avenue and Cunningham Ave.
1978	Sumset Avenue Culvert Replacement.
1983	McKee Road Culvert Expansion.

Flood Insurance Requirements

In its current state, Lower Silver Creek cannot contain estimated one-percent flood discharges within its banks. Figure 2-5 shows areas prone to flooding in a one-percent runoff event based on information provided by the Watershed Program. Since Lower Silver Creek was excavated through a broad alluvial plain, when floodwaters leave its banks, they generally flow away from the channel as shallow sheet flow. Urbanization has tended to generally concentrate the flow of floodwater within street rights-of-way.

FILE NAME: J:\Scvw\08-Lower Silver CR\Drawings\ReportFigs\2-5b.dwg

Figure 2-5. Flood Prone Areas



Source: Coyote Watershed Program
CH2M Hill

Schaaf & Wheeler

PREVIOUS PLANNING STUDIES

A planning study prepared by the District in 1976 proposed to provide a concrete-lined trapezoidal channel for most of Lower Silver Creek between Highway 101 and Cunningham Avenue. This plan was abandoned in the early 1980s in favor of the NRCS (formerly SCS) plan of 1983. The original watershed plan examined five non-structural and three structural measures to provide one-percent flood protection. Of these eight plans, three were formulated for further alternatives analysis.

1) No Project;

2) Non-structural Floodplain Protection; and

3) Channel Enlargement and Floodproofing.

1998 NRCS Plan

In 1998 the NRCS developed a major update to their 1983 plan. They investigated new alternatives in an attempt to minimize the lineal feet of proposed concrete channel and incorporate more environmentally sensitive design elements. After examining eleven more non-structural and structural measures, three new alternatives were selected for further study and refinement:

1) Geomorphic Stream Restoration with Detention Basins;

2) Geomorphic Stream Restoration with Diversion Channels; and

3) Hybrid Vegetated Block Wall Channel.

The third alternative was recommended, and has been carried forward to the present project, refined as described in Chapter 5 of this report.

PROJECT OBJECTIVES

The basic objective of the Lower Silver Creek Reaches 1-6 Improvement Project is to provide a level of flood protection along Lower Silver Creek consistent with NRCS and District policies, and the policies of the Federal Emergency Management Agency (FEMA) as administered through the National Flood Insurance Program (NFIP).

District and NFIP regulations define the "base flood" as a flood having a one percent chance of being equaled or exceeded in any given year. Often this is referred to as a "one-percent" or "100-year" flood. This should not be confused with a flood that *will* occur once every one hundred years, but one that might occur once every one hundred years or so *on the average* over a very long period of time. In fact, over the life of a 30-year mortgage, there is a 26 percent chance of experiencing a flood equal or greater in magnitude than the base flood as demonstrated by Table 2-4. These probability concepts may have an impact on construction staging, particularly the timing of bridge replacements and protecting newly the excavated channel prior to the re-establishment of vegetation.

Table 2-4: Relative Risk of Various Flood Events

	5-year	10-year	100-year
Annual risk of event	20%	10%	1%
Risk of at least one event in 5 years	67%	41%	5%
Risk of at least one event in 10 years	89%	65%	10%
Risk of at least one event in 30 years	99.88%	96%	26%
Risk of at least one event in 50 years	99.998%	99%	39%
Risk of at least one event in 100 years	really high	99.997%	63%

Other Project Goals

Although the primary project objective is to provide a level of flood protection along Lower Silver Creek meeting District, NRCS and FEMA standards, additional project objectives include:

- balancing flood reduction with environmental restoration, community beautification, and recreational opportunities.
- providing efficient and cost-effective flood control maintenance to ensure that the District is able to maintain design system performance in the future;
- allowing for more natural geomorphic processes in Lower Silver Creek; and
- engendering community support for the proposed project.

CHAPTER 3
WATERSHED HYDROLOGY

This chapter documents hydrologic analyses within the Lower Silver Creek and Coyote Creek watersheds undertaken for this project. Design discharges are presented, and a conceptual plan for modified operation of Lake Cunningham as a flood control facility is described. These analyses:

1) Provide a basis for further hydraulic analysis, sediment transport consideration, and facility design within Lake Cunningham Park and the adjacent upstream reaches of Lower Silver Creek. Another consultant will perform this work.

2) Estimate design one-percent discharges for Lower Silver Creek from Cunningham Avenue downstream to Coyote Creek (Reaches 1 through 6).

3) Provide discharge estimates for more frequent return periods, at the request of several interested parties. Channel discharges for the two-year, five-year, and ten-year flow conditions are given.

BACKGROUND

The NRCS based its conceptual channel improvements for Lower Silver Creek on a set of discharge values of unknown origin that are within ten percent of earlier base flood flow estimates made by the Santa Clara Valley Water District. Within the District's hydrologic model, HEC-1 storage routing routines are used to account for attenuation provided by Lake Cunningham, which reduces large-event flows downstream of Cunningham Avenue. The intent of this work is to reconfirm the performance of Lake Cunningham, and propose feasible operating modifications that can minimize downstream one-percent design discharge, while providing for the safe storage of excess runoff volume in a reasonable fashion that the City of San Jose can agree to.

Analytical Methods

In November 2000 Nolte Associates, Inc. completed a hydrologic study of the Lower Silver Creek watershed above Lake Cunningham for the District. Their analysis is based on methods and procedures outlined in the District's 1998 Hydrology Procedures Manual. The District directed Schaaf & Wheeler to expand the study to include the entire Lower Silver Creek watershed to its confluence with Coyote Creek. Further direction was given to follow the same procedures and methods provided in the Nolte study. Any modifications to the methodologies outlined by Nolte or the District are fully explained within this chapter.

Nolte prepared an HEC-1 rainfall-runoff model of the Lower Silver and Thompson Creeks watershed from the drainage boundary to Lake Cunningham. Hydrologic methodologies and assumptions are outlined in Table 3-1. The same methodologies and assumptions are made for the new watershed model downstream of Lake Cunningham as were made for the upstream model prepared by Nolte.

Table 3-1: Hydrologic Methodologies

Hydrologic Parameter	Upstream and Downstream Models
Design Storm	100-year, 24-hour, 15-min Standard Project General Storm for Northern California Coastal Streams
Precipitation Depth	SCVWD Precipitation Gages at City of San Jose Haskins Ranch United Technology Corporation
Sub-basin Areas	USGS 7.5-minute Quadrangle
Land Use	City of San Jose 2020 General Plan
Soil Infiltration	SCS Curve Number Methodology
SCS Soil Groups	Santa Clara Valley Water District
Antecedent Moisture Conditions	"Lower Silver/Thompson Creeks Hydrology Study," Nolte Associates, November 15, 2000
Unit Hydrograph	Clark Synthetic
Storm Drain Routing	SCVWD urban area storage-discharge relationships
Channel Routing	Muskingum-Cunge

WATERSHED MODEL

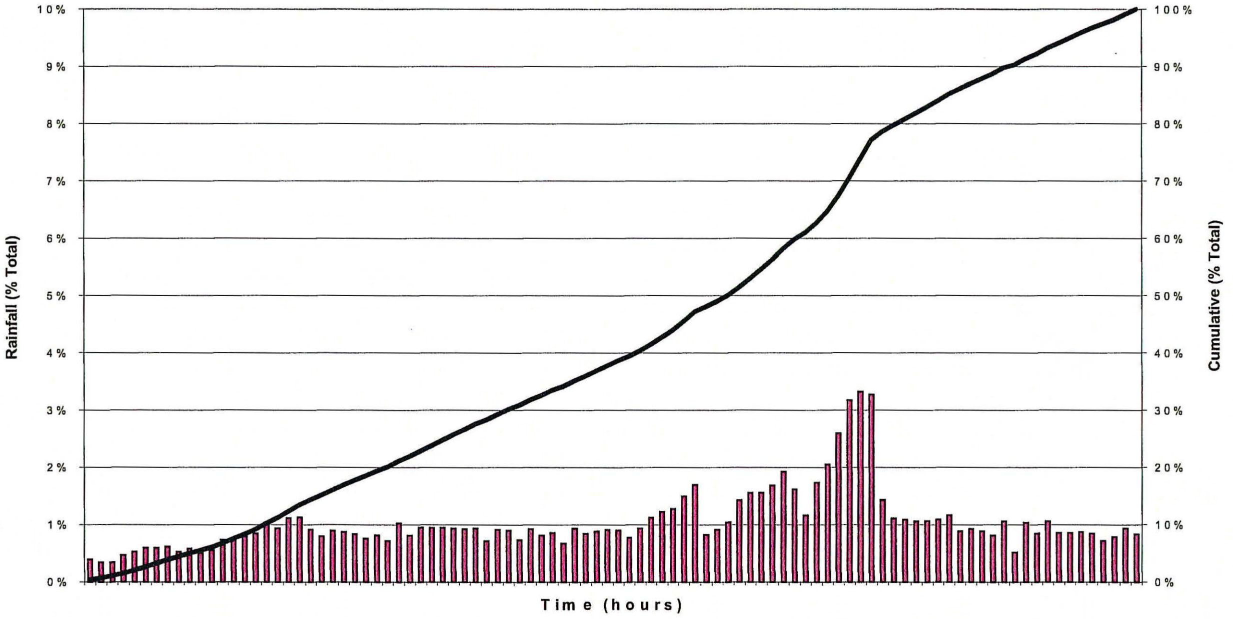
The aforementioned hydrologic methodology has been applied to the Lower Silver Creek watershed downstream from Lake Cunningham to construct a new watershed model.

Design Storm

The assumed rainfall distribution pattern is the District's normalized 24-hour, 15 minute Standard Project General Storm for Northern California Coastal Streams. This is the same storm pattern used in the Nolte study, and is shown graphically in Figure 3-1.

While this rainfall distribution pattern differs from the one used in the District's earlier model of the watershed, peak discharge estimates from the present study correlate well with previous estimates (see Table 3-3 on Page 3-13), as long as the same Lake Cunningham operating scenario is assumed.

Figure 3-1:
24-hour Standard Project General Storm for Northern California Coastal Streams



The selection of a particular precipitation pattern for design can affect peak discharge estimates and the timing of those peak discharges. To a lesser extent, the precipitation pattern can also alter the volume of predicted runoff depending upon soil infiltration; i.e. the pattern may affect the "initial abstract" depending upon antecedent moisture conditions. The new precipitation pattern peaks about ten hours later than the old pattern. Therefore, it is extremely important for anyone comparing the coincident timing of Lower Silver Creek and Coyote Creek discharges to be using consistent precipitation patterns.

Precipitation Depth

Table 3-2 provides a summary of rainfall depths at the three precipitation stations that surround this watershed. Following the Nolte methodology, precipitation depth is assumed to be the average depth of the three precipitation stations. Neither the 24-hour precipitation depth nor pattern is assumed to vary within the watershed.

Table 3-2: Precipitation Depths

Station	Precipitation Depth (inches)			
	2-year	5-year	10-year	100-year
UTC	1.57	2.31	2.76	4.01
Haskins Ranch	1.94	2.57	2.95	4.00
City of San Jose	1.52	2.25	2.76	4.42
Average	1.68	2.38	2.83	4.15

Basin Parameters

Sources for sub-basin areas, land use types and soil groups may be found in Appendix D. The Nolte model used an Antecedent Moisture Condition (AMC) of II¾ with the SCS methodology for soil loss (infiltration). This provides a close replication of previous estimates of peak inflow at Cunningham Avenue. Antecedent Moisture characterization by the SCS is given as:

AMC I	soils are dry
AMC II	average conditions
AMC III	heavy rainfall, or light rainfall with low temperatures; saturated soil.

Past hydrologic experience in the South Bay indicates that for a typical 24-hour storm, AMCs between II½ and II¾ tend to match statistical stream flow analyses for one-percent runoff. Therefore, using an AMC of II¾ for one-percent discharge estimation is reasonable. Estimates for two-year runoff use AMC I, since the Program is interested in how frequent sediment flushing flows might occur (see Chapter 6). Five-year discharge estimates assume average soil saturation equivalent to AMC II, while extreme event runoff estimates (10- and 100-year) assume AMC II¾.

The only modification made to the District's methodology as used by Nolte is that within urban sub-basins, District formulae for times of concentration apply only to the initial time of concentration, usually on the order of 15 minutes. A travel time from the most distant hydrologic element to the basin outlet has been added, calculated from basin slopes and gutter velocities. Without this final calculation, basin lag times tend to be underestimated with a consequent increase in peak discharge.

LAKE CUNNINGHAM

An examination of Lake Cunningham is integral to the watershed modeling effort. Lake Cunningham is a dual-purpose recreational and flood control facility. Its flood control function occurs during high runoff events when floodwater spills out of Silver Creek over a weir near Cunningham Avenue into the park. This analysis is intended to establish a preliminary weir elevation and describe the improvements necessary to control the flow of water downstream.

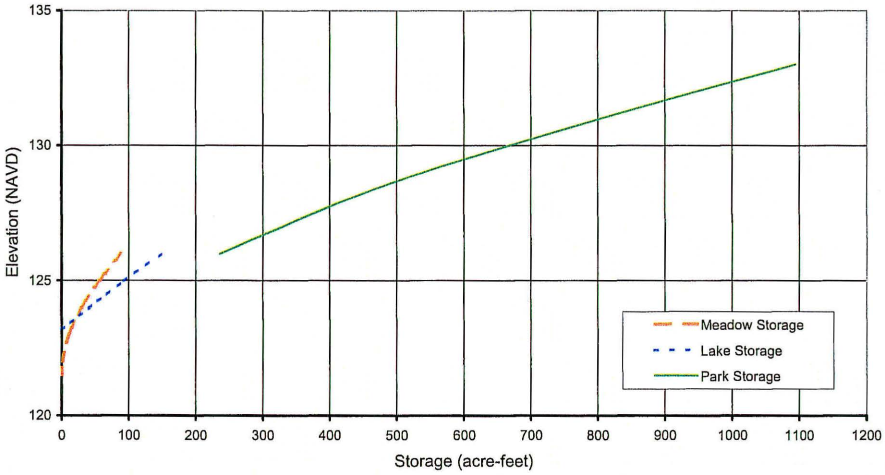
A May 2, 1978 agreement between the Santa Clara Valley Water District and the City of San Jose set forth acceptable conditions of operation for Lake Cunningham. According to this agreement, 380 acre-feet of flood storage are to be provided below an elevation of 125 feet NGVD (equivalent to roughly 128 feet NAVD), and at least 860 acre-feet of total storage must be provided below elevation 130 feet NGVD, or 133 feet NAVD. Correspondence to the City of San Jose in December 1981 indicated that the overflow weir from the creek into the park (set "temporarily" at elevation 127 feet NGVD) would be lowered to elevation 125.9 feet NGVD after Lower Silver Creek was improved. The maximum ponding elevation in the park was given as 127 feet NGVD, or 130 feet NAVD. In March 1982, the District wrote to the Soil Conservation Service (now NRCS), indicating that the maximum elevation of flooding would be elevation 125.9 feet NGVD, but this letter may have mistaken the ultimate weir elevation for the maximum level of flooding. The 1983 NRCS plan was based on the use of 590 acre-feet of flood storage to attenuate downstream flood flows.

Available Storage

Topographic surveys provided by the District indicate that 425 acre-feet of storage are available at elevation 128 feet NAVD, and 1,100 acre-feet are provided at elevation 133 feet NAVD. The NRCS's maximum storage volume of 590 acre-feet equates to an actual flood elevation of roughly 129 feet NAVD. Additional detailed surveying will be required, but a cursory examination of available topography suggests that park inundation could be allowed to an elevation of 131 feet NAVD before water would reach permanent structures.

Based on recent surveys, the as-built park grading provides more storage volume than required by the 1978 agreement, which was the basis of the 1983 NRCS analysis and watershed plan. The scope and cost of channel improvements to Lower Silver Creek downstream of Lake Cunningham have increased since 1983, so the objective of this analysis is to utilize additional available lake storage to minimize downstream releases while maintaining maximum flood levels at or below elevation 130 feet NAVD. Figure 3-2 shows available storage volume for the Big Meadow, Lake Cunningham, and the combined park.

Figure 3-2: Storage in Lake Cunningham Complex



Proposed Control Structures

Three variables are available to optimize lake storage and reduce flow down Lower Silver Creek: the size of the culvert/bridge opening at Cunningham Avenue, the length of the weir into the park and the elevation of the weir. The crossing at Cunningham Avenue works as a choke, allowing lower flows through and holding higher flows back. The weir elevation and length determine when and how much flow spills into the park. If the weir allows too much flow into the lake early in the storm, the volume will be used up and the peak will not be reduced enough. Likewise, if the weir is undersized it won't let enough flow into the lake, sending too much flow down the creek.

A preliminary hydraulic model of the downstream creek system has been used to establish backwater conditions at Cunningham Avenue. The model represents 30-percent design improvements from Coyote Creek to Interstate 680, and NRCS conceptual improvements from 680 to Cunningham. (Additional modeling will be required using the final hydraulic model once design for Reaches 1 through 6 is complete to confirm backwater conditions at Cunningham Avenue.) Because the final location of the weir is unknown, this analysis does not consider the effects of backwater upstream of Cunningham Avenue. This too will need to be refined by others at final design. Analysis assumes that flow leaves Silver Creek only at the weir. A rating curve of spill flow versus elevation follows the equation:

$$Q = C_w L h^{\frac{3}{2}}$$

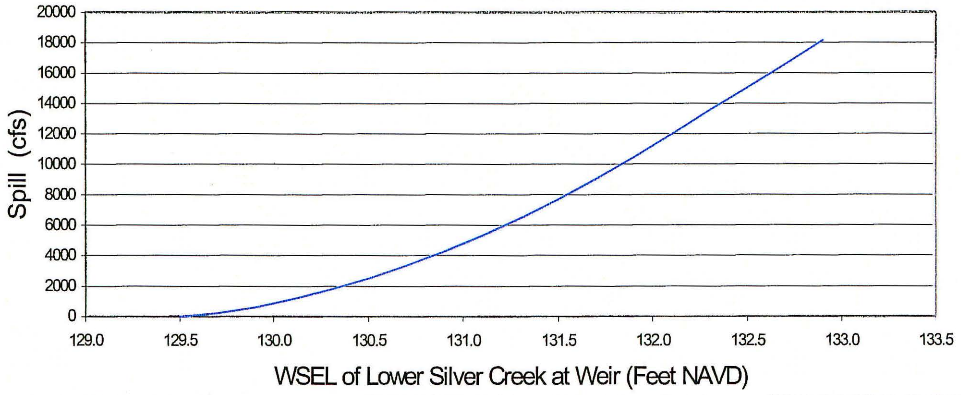
where Q = discharge over weir (cfs)
C_w = weir coefficient (dimensionless)
L = weir length (feet)
h = distance between the creek's energy grade line and weir crest (feet)

Since the actual weir cross section is subject to further evaluation within the context of park function, a value of 2.6 for C_W based on a broad-crested weir is assumed.

Combinations of varying culvert widths, weir lengths and elevations have been modeled to establish a workable preliminary design concept. In one scenario, the Cunningham Avenue Bridge would be modified using vertical walls to restrict the width of opening to 34 feet, and a concrete base slab would fix the height of opening to 8 feet. A hard floor at the bridge is essential to maintain the size of the control structure opening by preventing scour. (An enlarged opening would allow additional flow down the creek.) In combination with this control structure, a 900-foot long weir with a crest elevation of 129.5 feet (NAVD), near the Cunningham Avenue crossing, diverts a significant amount of runoff into the park without jeopardizing permanent structures.

Figure 3-3 provides a rating curve of overflow from Lower Silver Creek to the Big Meadow, based on the parameters listed previously. Subsequent work will be necessary to re-establish this rating curve based on actual backwater profiles between Cunningham Avenue and Tully Road that result from necessary channel improvements within this reach. Sedimentation may also affect the backwater profile on the weir crest. In addition, the final design configuration of the weir, both its location and cross section, may change the rating curve. Hence it may be necessary to modify the preliminary weir length and crest profile to achieve the flow attenuation described in this report.

Figure 3-3: Rating Curve for Spill to Big Meadow



Proposed Lake Operation

Previously described storage-elevation and weir flow rating curves have been used in conjunction with HEC-RAS backwater analyses to model stream releases and weir overflows. (See Appendix D for documentation.) A passive system of controls is proposed to operate Lake Cunningham during flood events. Between the Big Meadow and Lake Cunningham, a secondary weir 1,000 feet in length at elevation 126 NAVD (consistent with existing topography) is proposed to control the overflow of floodwater from the meadow into the lake. Neither the Cunningham Avenue control structure nor the weirs require monitoring or actual operation.

Meadow inundation may be fairly rapid as Figure 3-4 shows; with the entire meadow flooded to a depth of about three feet in two hours, and to a depth of six feet within five hours. Ultimately the park should be inundated to a maximum elevation of 129.4 feet NAVD during the design 100-year event. Total inflow at the control structure (Nolte hydrograph), downstream releases, and water surfaces in both the Big Meadow and Lake Cunningham are represented in Figures 3-4 and 3-5.

Figure 3-4: Lake Cunningham Design Operation

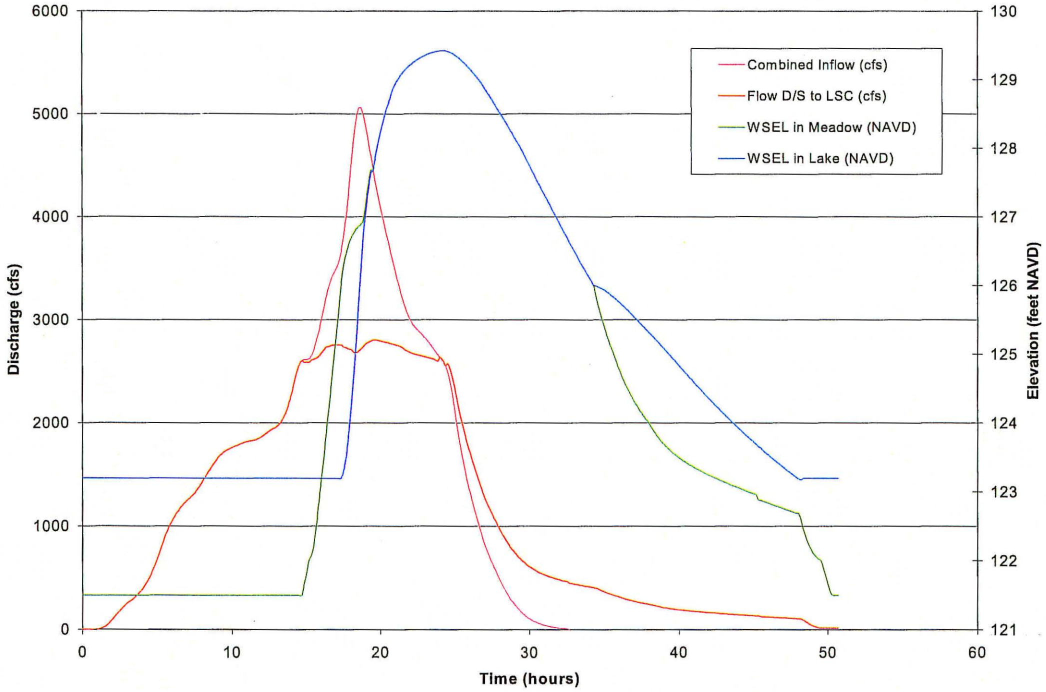
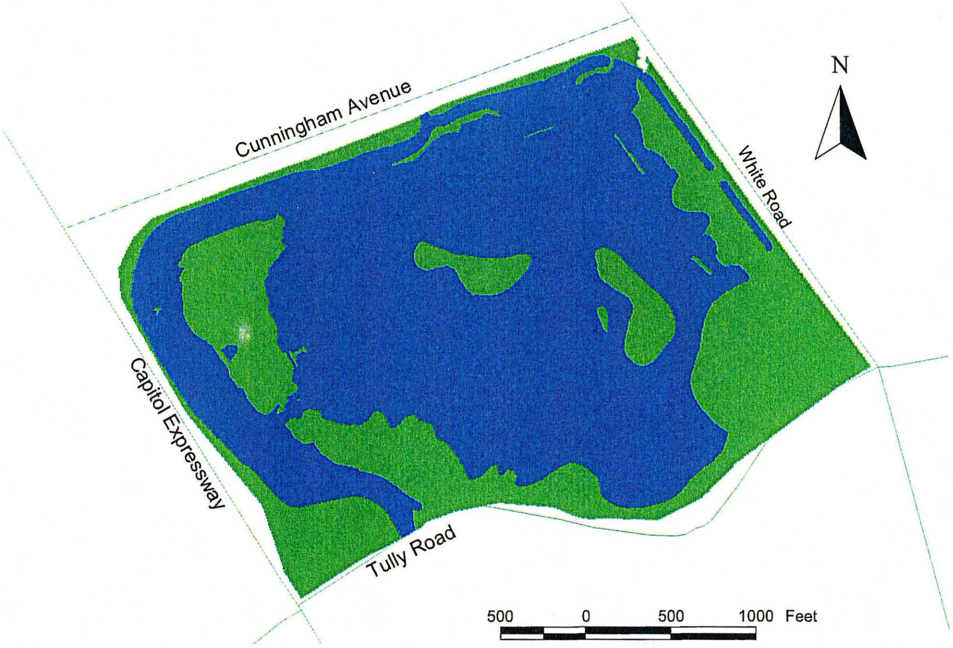
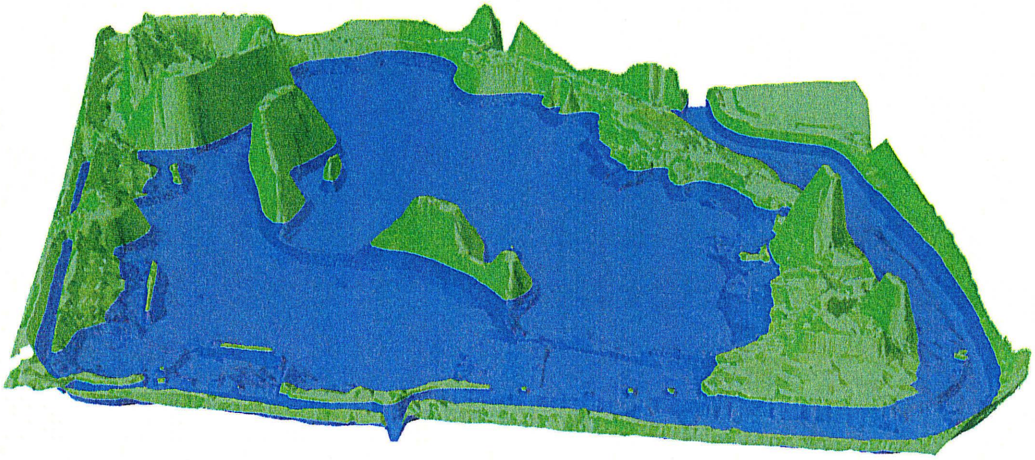


Figure 3-5: Lake Cunningham Inundation During Design Runoff Event

(Limit of maximum one-percent inundation shown in blue.)





3D Image Looking South with Cunningham Avenue in Foreground and Capitol Expressway to Right
(Note exaggerated vertical scale.)

The peak inflow of 5,060 cfs is reduced to 2,800 cfs by the system of controls, which spills 590 acre-feet of water into the park. This volume of water floods the park to an elevation of 129.4 feet NAVD, which is below the crest of the Lower Silver Creek weir at elevation 129.5 feet.

Conceptual Drainage Facilities

Provisions to drain floodwaters back out of Lake Cunningham and the Big Meadow are necessary to restore the recreational use of the park, and to prepare the flood control system for the next event. Figure 3-6 shows a conceptual section of a siphon between the lake and Big Meadow, which would be used to control the normal lake level. Currently the normal lake surface is at elevation 123 feet NAVD, but the City of San Jose would not necessarily be opposed to lowering this level to drop the permanent groundwater table in the Big Meadow. A siphon allows for the most efficient drainage of lake water, even with falling lake levels. The drainage cycle in Figure 3-4 is based on three 36-inch diameter siphons from the lake into Big Meadow.

Figure 3-7 shows a conceptual system that drains the Big Meadow concurrently. Six 36-inch diameter pipes have been assumed for the calculations. Under this scenario, the lake and meadow are drained within 18 hours of direct runoff cessation, or about 36 hours after water first spills over the control weir. A sub-drain system and pumps are recommended to dewater the meadow area. Flapgates are required on both drainage systems to prevent premature flooding. Faster drawdowns could be achieved by adding more siphons. Since the invert of Lower Silver Creek has been raised over time due to sedimentation, more refined improvement plans should examine methods for keeping the outfall clear and preventing local sediment accumulation. It is anticipated that this may be an area that requires extensive regular maintenance.

Performance Sensitivity

Proposed Lake Cunningham Park flood controls have been tested for hydraulic and hydrologic sensitivity. Calculations presented in Figure 3-4 are based on backwater control at Cunningham Avenue. Once the design of Lower Silver Creek channel improvements are completed, the overflow weir should be adjusted to function with either outlet control or inlet control conditions at the Cunningham Avenue control structure while maintaining the desired downstream release. With inlet control at Cunningham Avenue, the maximum downstream release is about 2,900 cfs.

Hydrologic sensitivity has been gauged by adding 20 percent to precipitation depths throughout the watershed. Under this condition, maximum inflow to the Lower Silver / Ruby Creek confluence increases to 5,860 cfs, the overflow weir is submerged, peak downstream release to Lower Silver Creek is about 3,000 cfs, and 1,050 acre-feet of water is stored within the park (Figure 3-8).

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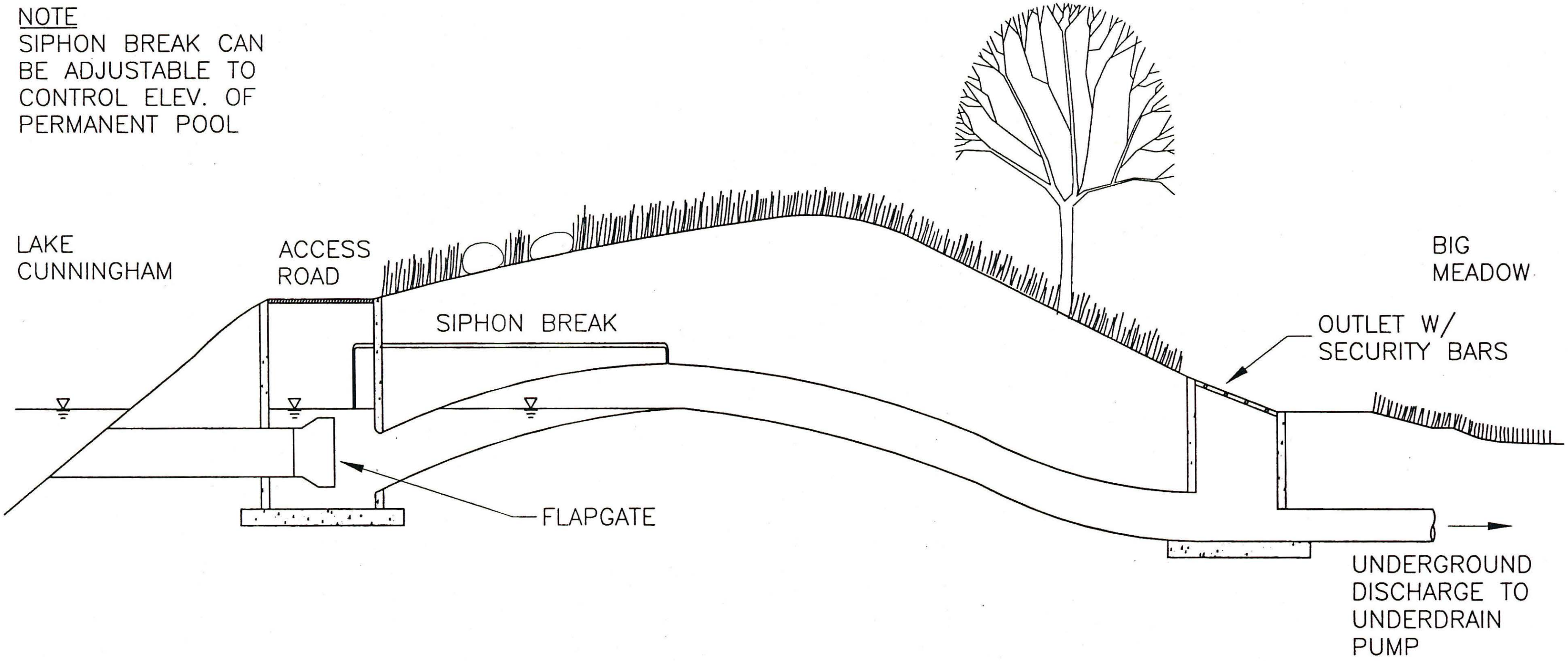
NOTE
SIPHON BREAK CAN
BE ADJUSTABLE TO
CONTROL ELEV. OF
PERMANENT POOL



LAKE DRAIN SIPHON

N.T.S.

Schaaf & Wheeler

Figure 3-6

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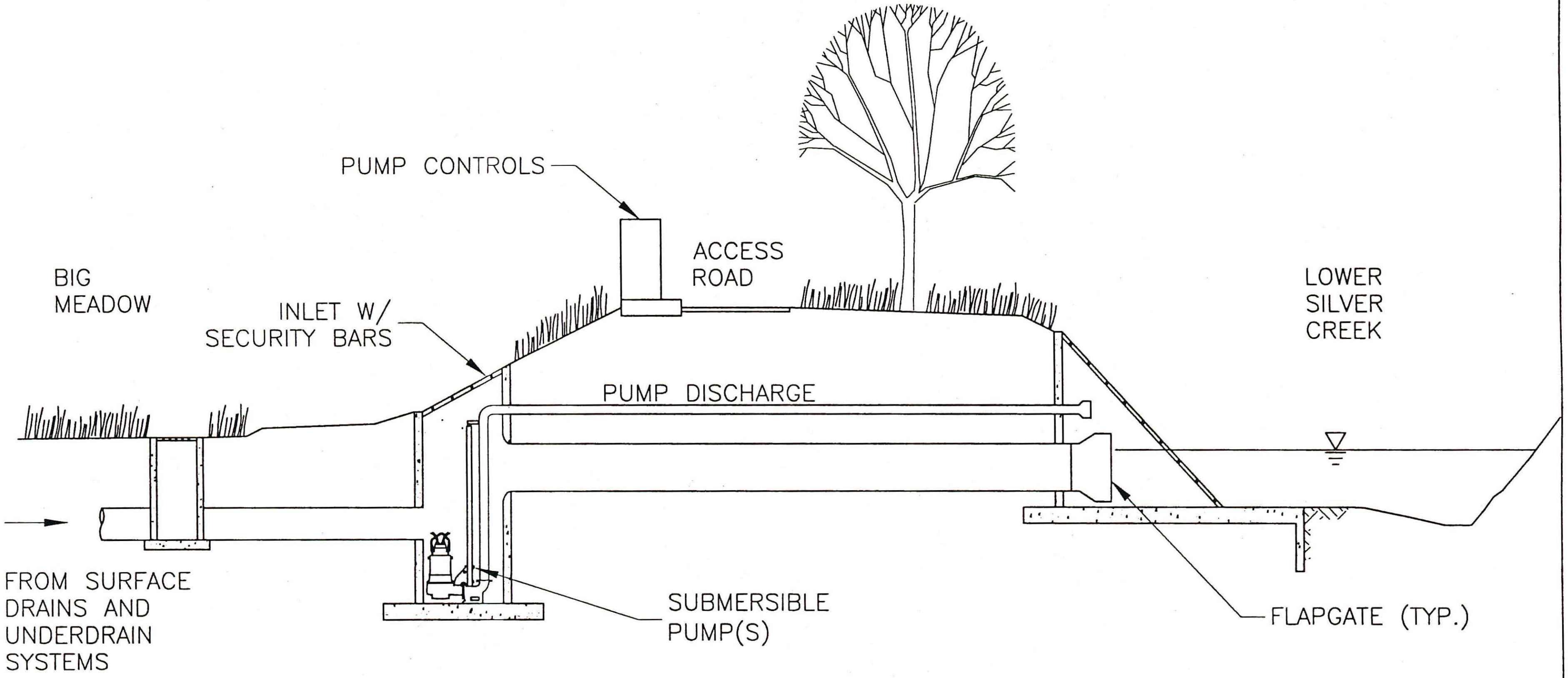
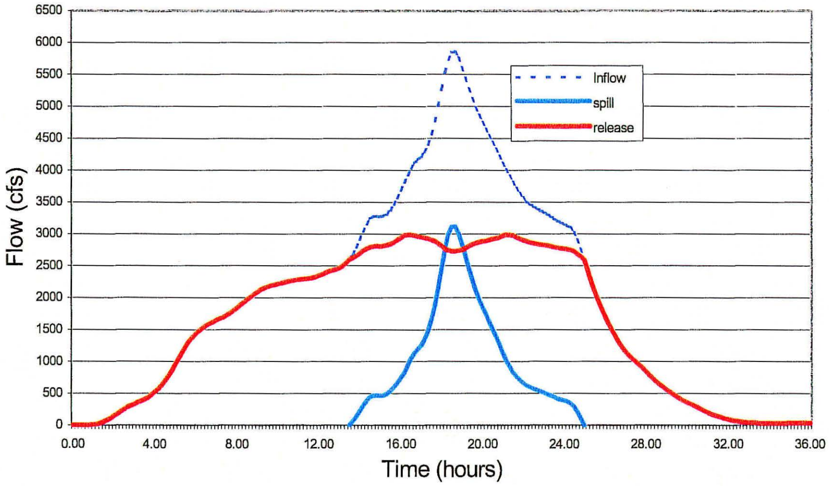


BIG MEADOW DRAIN

N.T.S.

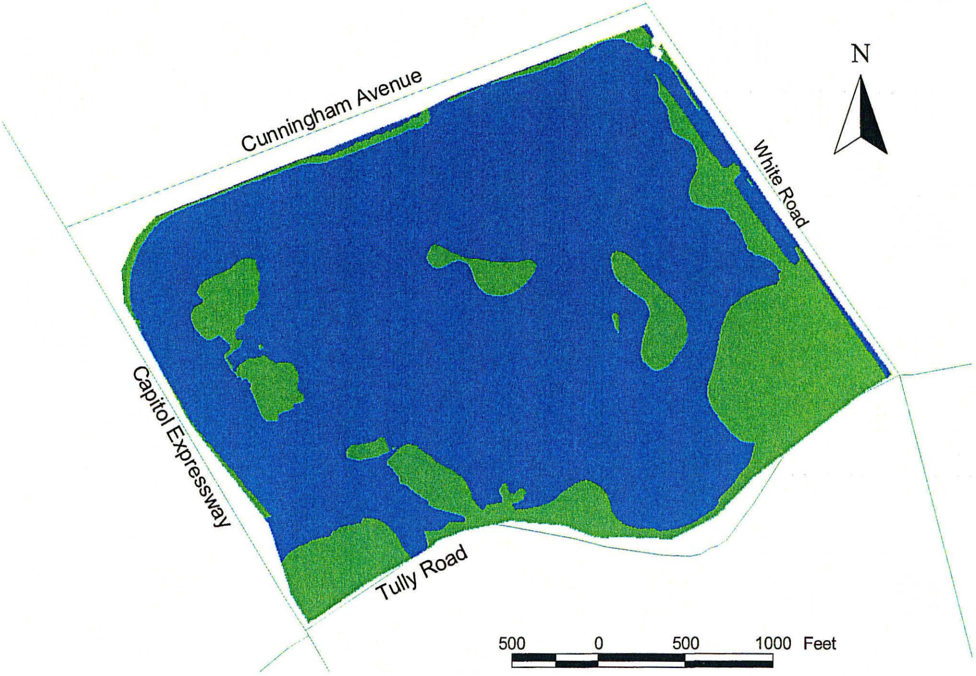
Figure 3-7

Figure 3-8: Downstream Release w/ 20% Increase in Rainfall



Hydraulic modeling indicates that the additional flows in Lower Silver Creek would be contained within the freeboard of proposed channel improvements. The amount of water stored in the park complex nearly doubles, inundating the park to an elevation of 133 feet NAVD (Figure 3-9), assuming that the flooding is contained. (The current point of first release to Capitol Expressway is at elevation of about 132 feet NAVD just downstream of Tully Road.)

Figure 3-9: Lake Cunningham Inundation w/ 20% Increase in Rainfall
(Limit of maximum inundation shown in blue.)



Design Resolution

Several issues need to be addressed during detailed Lake Cunningham flood control design. Between Cunningham Avenue and Tully Road, Lower Silver Creek and Ruby Creek must convey their design discharges without premature spill into the meadow or lake. Sedimentation and maintenance within these reaches should also be considered. A point of first release from the system (e.g. to Capitol Expressway) is also necessary to establish maximum emergency flood levels within the park, as well as maximum downstream discharges. The release should assure that emergency spills take place only when design inflow exceeds the one-percent magnitude. Finally, the system of levees that contain floodwater within the park must meet state and federal standards.

DESIGN DISCHARGE ESTIMATION

Table 3-3 compares design discharges used by the NRCS in their 1983 watershed plan to predicted NRCS discharges as modified by the proposed lake operation plan discussed in this report, and the results of the new hydrologic methodology with aforementioned lake operation. The table demonstrates that proposed changes to Lake Cunningham could reduce the NRCS design discharges by ten to twenty percent. Applying the new hydrologic methodology in this watershed changes estimated discharges by less than four percent, given the proposed changes at Lake Cunningham.

Table 3-3: Comparison of Design Discharges

Location	Discharge (cfs)			% Δ due to Lake Changes	% Δ due to Methodology
	Original NRCS (590 ac-ft)	NRCS with Proposed Lake Changes	New Method with Proposed Lake Changes		
Cunningham Ave.	3,600	2,810	2,810	-22	0
Ocala Ave.	3,600	2,900	---	-19	---
S. Babb Creek	4,210	3,820	3,670	-9	-4
N. Babb Creek	4,600	4,080	4,160	-11	+2
Interstate 680	4,830	4,230	4,210	-12	0
Alum Rock Ave.	4,830	4,290	4,340	-11	+1
Miguelita Creek	5,630	4,860	4,920	-14	+1
Highway 101	5,630	5,160	5,220	-8	+1
Coyote Creek	5,630	5,150	5,220	-9	+1

More Frequent Discharges

Watershed modeling results for more frequent storm events are summarized in Table 3-4. Antecedent moisture conditions for various return periods have been previously discussed. Precipitation depths are taken from City of San Jose rain gauge statistics.

Table 3-4: Design Discharges on Lower Silver Creek

	Discharge (cfs)			
Location	2-year	5-year	10-year	100-year
Lake Inflow	610	2,040	3,400	5,060
Cunningham Avenue	610	2,040	2,650	2,810
S. Babb Creek	680	2,420	3,310	3,670
N. Babb Creek	780	2,630	3,640	4,160
Interstate 680	780	2,650	3,670	4,210
Alum Rock Avenue	810	2,730	3,780	4,340
Miguelita Creek	890	2,940	4,160	4,920
Highway 101	940	3,050	4,360	5,220
Coyote Creek	940	3,050	4,360	5,220

Frequency of Park Inundation

Based on revised watershed modeling, the proposed improvement project should pass a five-year discharge without any spill into Lake Cunningham Park, but spill would occur in a ten-year design event. During a ten-year runoff event, the peak overflow is estimated to be 750 cfs, with spills lasting about two hours. Roughly 125 acre-feet of water would be stored in the park, which exceeds the storage capacity of the meadow (88 acre-feet). Consequently, overflow from the meadow into the lake is anticipated to occur during a ten-year event.

COINCIDENCE WITH COYOTE CREEK

Water surfaces elevations, particularly in the lower reaches of Lower Silver Creek, can be directly influenced by conditions in Coyote Creek at the confluence. Backwater calculations presented in Chapter 5 have been made using the best available information regarding Coyote Creek, since recent detailed hydrologic and hydraulic analyses for the entire Coyote Creek watershed, of which Lower Silver Creek is a part, are not available.

Design Hydrographs

According to the NRCS, increasing the capacity of Lower Silver Creek by improving the channel will have a minimal impact on peak flows and volumes in Coyote Creek. (NRCS, 1998.) During a 100-year runoff event, their peak discharge from Lower Silver Creek occurs about 60 hours before the peak discharge from Coyote Creek. At the time of peak runoff from Silver Creek, Coyote Creek is discharging about 2,000 cfs, or one-sixth of its 100-year peak discharge. When Coyote Creek peaks, Lower Silver Creek is projected to discharge only base flow. The NRCS predictions are not based upon comparison of hydrologic models constructed using similar procedures. Rather, they are made using a "time of concentration graph" without sufficient documentation to verify. An examination of the District's ultimate conditions hydrologic model for the Coyote Creek watershed reveals more coincident 100-year peak discharges than assumed by the NRCS (Table 3-5).

Table 3-5:
Coincidence of 100-year Discharge at the Lower Silver Creek / Coyote Creek Confluence
(Source: HEC-1 Model "COY1" Obtained from SCVWD)

Time (hours)	Description	Coyote Creek Discharge Downstream of LSC (cfs)	Lower Silver Creek Discharge (cfs)
45	Lower Silver Creek Peak	10,770	5,480
69	Coyote Creek Peak	15,740	3,560

Lower Silver Creek peaks at 45 hours, when the combined discharge in Coyote Creek downstream of the Silver Creek confluence is about 70 percent of the estimated peak combined discharge. Coyote Creek peaks at 69 hours when the flow in Lower Silver Creek is 65 percent of its peak discharge of 5,480 cfs as estimated by the District model. (For the ten-year runoff condition, the two creeks are nearly coincident.) It is noted that the Coyote Creek watershed model referenced in Table 3-5 uses a different design storm and methodology than the revised Lower Silver Creek model, but that the older model provides the best available information regarding the relative timing of peak discharge.

Starting Water Surface Elevations in Lower Silver Creek

FEMA has published guidelines for computing water surface profiles in unregulated watersheds, which may be of some assistance in this study even though the watershed is regulated by Lake Cunningham. According to FEMA, the starting water surface elevations for profile computations on a tributary may be based on normal depth unless a coincident peak situation is assumed. Generally the assumption of coincident peaks is appropriate if:

- the ratio of the drainage areas for the two creeks lies between 0.6 and 1.4;
- the times to peak for the combining flows are similar for the two combining watersheds; and
- the likelihood of both watersheds being covered by the design storm is high.

The Lower Silver Creek watershed covers 45 square miles, or only about 18 percent of Coyote Creek's 248 square mile watershed at the confluence. And if the NRCS "time of concentration" analysis is correct, coincident peaks are not likely. Table 3-5, however, suggests that the peak discharges from each creek are 24 hours apart rather than 60 hours, so an assumption of normal depth at the confluence may not be appropriate.

Coupled with the likelihood that intense rainfall typically preceding extreme runoff events in northern California is caused by widely spread storm fronts, it is certainly possible that peak discharges in Lower Silver Creek will occur simultaneously with significant backwater from Coyote Creek. This is the basis for starting water surface elevations assumed for hydraulic analysis in this report. Further refinements of the operation plan at Lake Cunningham may also need to address the potential for downstream impacts to Coyote Creek, based on the timing of lake releases.

If the one-percent discharge in Coyote Creek is about 10,800 cfs when Lower Silver Creek discharge is at its peak, the starting water surface elevation at the confluence should be approximately equivalent to FEMA's published 50-year water surface elevation of 82.75 feet NAVD, which is based upon a combined discharge of 10,300 cfs. If the proposed channel configuration is analyzed with this starting condition, the design one-percent water surface profile does not approach the top of natural bank until upstream of Highway 101 where floodwalls are planned. The water surface appears not to significantly overtop existing banks anywhere in Reaches 1 or 2. By comparison, water surface elevations just upstream of Highway 101 assuming a normal depth starting condition for Lower Silver Creek are about six inches lower.

Also analyzed is the existing condition assuming that Coyote Creek is at its peak one-percent discharge with a water surface elevation at the Lower Silver Creek confluence of 84.75 feet NAVD. For this case, Lower Silver Creek discharges are assumed to be 65 percent of their maximum values. The results of each analysis are superimposed upon one another, and the higher water surface elevation between the two cases governs the recommended design at every location.

The ten-year water surface profile for Lower Silver Creek assumes a coincident ten-year Coyote Creek water surface elevation of 79.75 feet NAVD, as published by FEMA.

CHAPTER 4

DESIGN CRITERIA

This chapter documents hydraulic parameters used to design channel improvements for Lower Silver Creek Reaches 1 through 6. Hydraulic parameters discussed include:

1) channel roughness;
2) bridge modeling techniques and transition losses;
3) freeboard requirements; and
4) maintenance criteria.

CHANNEL ROUGHNESS

In one-dimensional open channel flow analysis as performed using HEC-RAS, a single parameter known as "Manning's n" is used to represent the retarding forces to flow imposed by the channel. Values for "n" are published in the literature, and in the absence of high water marks with which to calibrate stream reaches with known discharge, are often relied upon for channel design. When selecting roughness values for design, it is important to remember that in one-dimensional flow, Manning's "n" accounts for the flow resistance due to a host of hydraulic phenomena beyond boundary shear. Other factors may include the effects of eddies, cross-waves, super-elevation, bed forms, sediment and debris.

Roughness Elements

Several sources have been used to estimate roughness factors for water surface profile determination within Lower Silver Creek. These include "n" values published by Henderson (1966) and Chow (1959), engineering judgment, and procedures outlined by the Corps of Engineers for roughness values within concrete lined channels (ASCE, 1995). Table 4-1 summarizes design channel roughness values of various channel elements proposed for use in hydraulic analysis.

Given the uncertainty in "n" value selection, a range of "n" values is used to examine channel performance. Lower values tend to increase channel velocity, which may be important in terms of scour or wave formation. Higher values tend to maximize water depth, and will generally set freeboard requirements. For vegetal channel linings, typical "n" values for temporary erosion control materials will be used to evaluate high flow velocities. Manning's "n" values that are contingent upon maintenance conditions are so indicated.

Table 4-1: Manning's "n" Values for Hydraulic Analysis

Element	High "n" for depth	Low "n" for velocity
Concrete Lining	0.018	0.011
Bare Earth	0.030	0.020
Erosion Control Blanket	---	0.020
Gravel Maintenance Road	0.025	0.020
Vegetated Gabion Mattresses or Walls	0.045	0.030
Vegetated Block Slopes	0.045	0.030
Grass Lining (Mowed to <12")	0.040	0.020
Emergent Wetland (Maintained)	0.050	0.020
Grass Lining (No maintenance)	0.060	0.020
Emergent Wetland (No maintenance)	0.100	0.020
Trees, shrubs, vines (No maintenance)	0.150	0.020
Rock Slope Protection	$0.034(d_{50})^{1/6}$	$0.034(d_{50})^{1/6}$

Composite Roughness Calculations

By design, the roughness along the wetted perimeter of Lower Silver Creek varies across each cross section. For instance, at an individual cross section location, the channel might contain elements of emergent wetland, grass lining, trees, shrubs, and a maintenance road. To compute water surface elevations in a channel with variable roughness using a one-dimensional model (i.e. with a mean velocity), it is necessary to estimate an effective (composite) roughness value for each cross section. Flow velocities vary across the channel due to variation in both the flow depth and roughness from one channel element to the next. To calculate mean flow velocity without actually subdividing each channel section, several methods have been suggested in the literature for estimating a composite roughness value within non-uniform channels.

HEC-RAS calculates a composite "n" value based on an assumption that average velocities within each channel element are equal and equivalent to the mean channel velocity as a whole. (HEC, 1998) Since this is not the case for Lower Silver Creek, a more appropriate method that weights "n" by channel conveyance is used herein.

As described by Chow (1959), Lotter assumed that the total discharge in each section is equal to the sum of the discharges of individual areas subdivided by roughness (i.e. conservation of mass). The resultant equivalent roughness coefficient formula, consistent with US Army Corps of Engineers engineer manual EM 1110-2-1601, is provided by Chow as Equation 6-19:

$$n = \frac{P\,R^{5/3}}{\sum\left(\frac{P_N\,R_N^{5/3}}{n_N}\right)} = \frac{P\,R^{5/3}}{\frac{P_1\,R_1^{5/3}}{n_1} + \frac{P_2\,R_2^{5/3}}{n_2} + \ldots + \frac{P_N\,R_N^{5/3}}{n_N}}$$

where n = composite roughness coefficient for cross section
P = total wetted perimeter of cross section (feet)
R = total hydraulic radius of cross section (feet)
P_i = wetted perimeter of cross section element i (feet)
R_i = hydraulic radius of cross section element i (feet)
n_i = Manning's roughness coefficient for cross section element i

Appendix E details the calculation of composite roughness values for each channel reach.

Because the distribution of velocities is not uniform across channel sections, the velocity head is generally greater than the value computed when using the mean velocity. (Chow, 1959) The actual velocity head is represented by the term ▒$V^2/2g$; where V is the mean velocity, and ▒ is known as the energy coefficient, velocity coefficient, or Coriolis coefficient, determined from:

$$\alpha = \frac{\int v^3\,dA}{V^3\,A}$$

where α = velocity coefficient (dimensionless)
v = velocity within an individual channel element (feet per second)
V = mean channel velocity (feet per second)
A = cross sectional area (square feet)

BRIDGE MODELING

In addition to the energy required to overcome channel resistance, structures such as bridges and culverts also cause energy losses, which can result in a raised water surface profile. Methods provided by HEC-RAS for analyzing bridges and culverts under low flow and pressurized conditions are employed in the backwater computations.

Several methods are available through HEC-RAS to compute energy losses through a bridge. The "energy only" or standard step method handles a bridge section without piers in the same manner as a natural river section, except that the area between the low chord of the bridge (soffit) and the top of road is subtracted from the total cross-sectional area, and the wetted perimeter is increased where water is in contact with the bridge. Increased frictional resistance due to the added wetted perimeter is included in the energy loss through the structure.

When bridge piers are present, either conservation of momentum may be applied by using a coefficient of drag, or Yarnell's method may be used for subcritical "Class A" low flow through the bridge. Table 4-2 provides proposed drag coefficients for the momentum method and pier shape coefficients for Yarnell's low flow bridge loss calculations, respectively.

Table 4-2: Pier Coefficients

Pier Shape	Drag Coefficient	Pier Coefficient
Semicircular Nose and Tail	1.33	0.90
Multiple Cylinders	1.33	1.00
Triangular Nose and Tail	2.00	1.05
Square Nose and Tail	2.00	1.25

When the computed water surface elevation is above the bridge soffit, a "pressure/weir" feature can compute losses through the structure for pressure (orifice) flow, weir flow over the top, or a combination of both. (For Lower Silver Creek, weir flow over bridges is not allowed.) Changes to the water surface profile resulting from the bridge are calculated based on hydraulic formulae that estimate the change in energy and water surface elevation through the bridge. Other hydraulic routines are also available to perform the same function for standard culvert shapes.

Coefficients of discharge for orifice flow during bridge pressurization are evaluated on a case-by-case basis using the guidelines outlined in Table 4-3. When an orifice is located close to the bottom or bank of the channel, the approaching flow is guided so that the orifice contraction is suppressed on those sides of the orifice close to such guides. Clear span bridges across trapezoidal or U-frame (rectangular) channels are examples of orifices contracted on three sides.

Table 4-3: Orifice Coefficients

Condition	Orifice Coefficient
Orifice in Thick Wall (typical bridge)	0.80
Submerged, square-edged	0.80
Submerged, well-rounded	0.90
Increase in C per number of contracted sides	0.04

Transition Losses

An energy loss also takes place just upstream and downstream from each structure as flow contracts and expands into and out of the bridge or culvert. The following contraction and expansion coefficients for channel transitions are used in the hydraulic models (Table 4-4). Wherever turbulent conditions create the potential for energy loss, contraction and expansion coefficients are increased. Other transitions include channel bends, resting pools, and maintenance access ramps.

Table 4-4: Expansion and Contraction Coefficients

Transition Type	Contraction	Expansion	Source
Gradual	0.1	0.3	HEC
Warped	0.1	0.2	Chow
Wedge	0.3	0.5	Chow
Square End	0.3	0.75	Chow
Abrupt	0.6	0.80	HEC

FREEBOARD

The use of design "freeboard" provides a measure of safety that compensates for the many unknown and difficult-to-quantify parameters that affect the calculation of flood elevations. These factors include uncertainty in rainfall data, soil loss parameters, watershed urbanization, wave action, debris at bridge openings, and general uncertainties in hydrologic and hydraulic procedures. Freeboard is usually expressed in terms of feet above the design base flood elevation. To meet FEMA standards, freeboard is necessary whenever a levee system, including structural floodwalls, is used to provide flood protection.

When mapping flood-prone areas, FEMA only recognizes those levee systems meeting their criteria, which includes a minimum three feet of freeboard whenever the design one-percent water surface elevation is carried above the natural ground elevation. An additional six inches of freeboard (3.5 feet above the water surface) is required at the upstream end of the levee / floodwall system, tapering to the minimum freeboard of 3.0 feet at the downstream end of the levee. For this reason, the District has adopted a uniform freeboard criterion of 3.5 feet. An additional foot of freeboard (4.0 feet above the water surface) must be provided within 100 feet of each side of any structure, such as a bridge or culvert.

FEMA does not impose a freeboard requirement when the base flood can be carried without the use of a levee system. The District, however, does have additional project freeboard requirements for design projects (SCVWD, 1994), which can be more restrictive than FEMA's actuarial criteria. Table 4-5 provides the respective criteria, where "D" refers to the estimated depth of flow in feet, and "V" is flow velocity in feet per second.

Table 4-5: Freeboard Requirements

Situation	FEMA (Feet)	District (Feet)
Water Surface Above Natural Bank Elevation	3.0	3.5
Water Surface Above Bank within 100 feet of Structure	4.0	4.0
Water Surface Below Natural Bank Elevation	N/A	$0.2(D + V^2/2g)$
Minimum Freeboard	N/A	1.0

District criteria for water surfaces below natural bank elevation are based on NRCS guidelines. Recently the NRCS has approved the use of a slightly different formula for its freeboard criterion within incised channels; that is, where the design water surface is carried below the natural bank. The velocity head term has been omitted, leaving the required freeboard within an incised channel as the minimum of one foot or 0.2D, where D is flow depth. The NRCS has also approved a District-proposed method of weighting depth based upon flow conveyance, as stated in an October 31, 2001 memorandum from NRCS Design Staff Leader Bill Ward, P.E.:

> "[The NRCS] has determined that using a composite freeboard based on weighting the conveyance for individual channel areas within a section is a good approach for multi-staged channels and recommend[s] its use in these cases. To meet NRCS criteria you can simply use this procedure and replace the energy head with depth. Of course the minimum freeboard should not be less than one foot, and other requirements for freeboard (super-elevation, unstable range) are on top of the calculated composite freeboard."

The effect of differing conveyance within multi-staged channels is already accounted for by the calculation of composite roughness and velocity coefficients to produce an average water surface elevation. It is also recommended that the minimum freeboard be based on the hydraulic depth, which is the depth of an equivalent rectangular shaped channel (flow area divided by top width), and produces a weighted depth similar to the District's composite freeboard calculation. (Sample calculations that compare the District's composite freeboard procedure with the use of the hydraulic depth are provided in Appendix E.) Furthermore, the energy grade line shall be contained within the channel or its floodwalls.

LEVEL OF MAINTENANCE

Regular channel maintenance is important to upholding the integrity of channel design. During preliminary and final design phases, proposed maintenance protocols on the part of the District will be iteratively evaluated for their impact on design channel roughness, but within the confines of the approved Lower Silver Creek Maintenance Plan of August 2000. For instance, natural elements including grasses and emergent wetlands that are allowed to become "contaminated" with woody vegetation such as brush, willows, and even trees would be assumed to have higher roughness values in the 0.10 to 0.15 range.

CHAPTER 5
CHANNEL HYDRAULICS

Base flood elevations within Lower Silver Creek are estimated using a one-dimensional steady state flow backwater analysis via the HEC-RAS public domain program. Steady state analyses are performed. The following civil engineering firms and agency have supplied proposed channel geometry information:

Reaches 1 and 2:	MacKay & Somps, Inc.
Reach 3:	Psomas, Inc.
Reach 4:	Ruggieri-Jensen-Azar & Associates
Reaches 5 and 6:	Coyote Watershed Program

Available data include record drawings for previously constructed bridges and culverts, proposed channel design plans, field surveys of existing topography for Lower Silver Creek supplied by the Program, and supplemental surveys performed by firms listed above. This information is supplemented by field surveys performed by Schaaf & Wheeler at every bridge or culvert crossing between Wooster Avenue and Cunningham Avenue.

METHODOLOGY

Flood flows can be carried within channels either as "subcritical" flow or "supercritical" flow, often referred to as "tranquil" and "rapid" flow, respectively. It is not the velocity of flow, however, that distinguishes the flow regime; rather, the flow regime is defined by how fast the water is moving relative to the velocity of the wave that results from a small disturbance in the water surface. Disturbances in subcritical flow move upstream; disturbances in supercritical flow cannot move upstream because such waves must be swept downstream. The Froude number (F_r), which is analogous to the Mach number for gas flow, is defined as the ratio of stream velocity to wave velocity:

$$F_r = \frac{v}{\sqrt{g\,y}}$$

where v = stream velocity (feet per second)
g = gravitational acceleration (feet per second squared)
y = water depth (feet)

A Froude number greater than unity signifies supercritical flow (stream velocity greater than wave velocity), while a Froude number less than one indicates subcritical flow. When the Froude number is between 0.8 and 1.2, however, the flow can be unstable, characterized by standing waves and other disturbances that may tend to propagate upstream or downstream depending upon the state of flow.

Because the Froude number depends on channel roughness, and "n" values are expected to vary within any given reach, the specific energy freeboard criterion has been kept to insure that the channel design provides protection against unexpected changes in the flow regime. Coincident backwater conditions from Coyote Creek (Chapter 3) and design criteria from Chapter 4 are used to establish required freeboard at the upper end of the design channel roughness range. Then normal depth starting conditions and the lower end of channel roughness are simulated to examine channel stability under mixed flow conditions; that is, with both supercritical and subcritical flow. Critical flow is assumed as the upstream boundary condition at Cunningham Avenue for the latter analysis.

Superelevation

At a limited number of locations discussed later in this chapter, the proposed channel is aligned along sweeping bends. The centrifugal force caused by flow around a curve raises the water surface on the outside wall of the curve, and depresses the water surface along the inside wall. This phenomenon is referred to as superelevation. In addition, curved channels tend to create secondary helicoidal flows that may persist downstream of the curve. Superelevation is checked with both high and low Manning's "n" values to determine the most critical case for wall freeboard. The maximum amount of superelevation above the level water surface predicted by HEC-RAS is given by the following equation (ASCE, 1995):

$$\Delta y = C\frac{V^2 W}{g\,r}$$

where Δy = the rise in water surface (feet)
C = a dimensionless coefficient (0.5 for subcritical flow in a simple circular curve in a rectangular channel; 1.0 for supercritical flow in the same type of curve)
V = mean channel velocity (feet per second)
W = channel width (feet)
g = gravitational acceleration (feet per second squared)
r = the radius of channel centerline curvature (feet)

EVALUATION OF PROPOSED CHANNEL IMPROVEMENTS

Before completing a detailed hydraulic analysis of the District's proposed design for the Lower Silver Creek Watershed Project, recent changes made to the NRCS proposed project plans are discussed in terms of hydraulic performance.

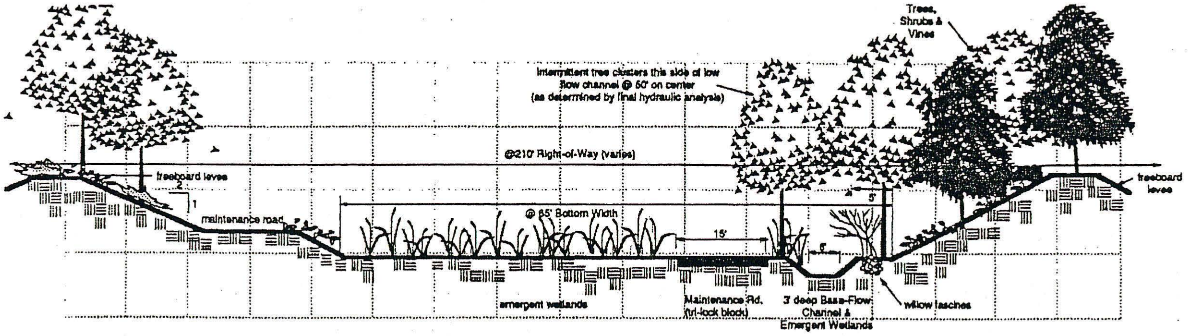
Evolution of Channel Design

In 1998, the NRCS prepared a set of conceptual drawings for the Lower Silver Creek Improvement Project. This set of drawings, portions of which are excerpted herein, was evaluated using preliminary hydraulic calculations that did not factor in backwater effects from Coyote Creek, existing or replacement bridges, or other channel transitions.

The District has since refined and enhanced the original NRCS plan to reduce the amount of concrete lining, utilize more natural and environmentally sensitive materials and configurations, provide for more natural channel geomorphologic processes, improve maintenance, and allow greater public access to the creek. As a result, the channel configuration has been revised in a few reaches, including the acquisition of additional rights-of-way to facilitate the channel enhancements.

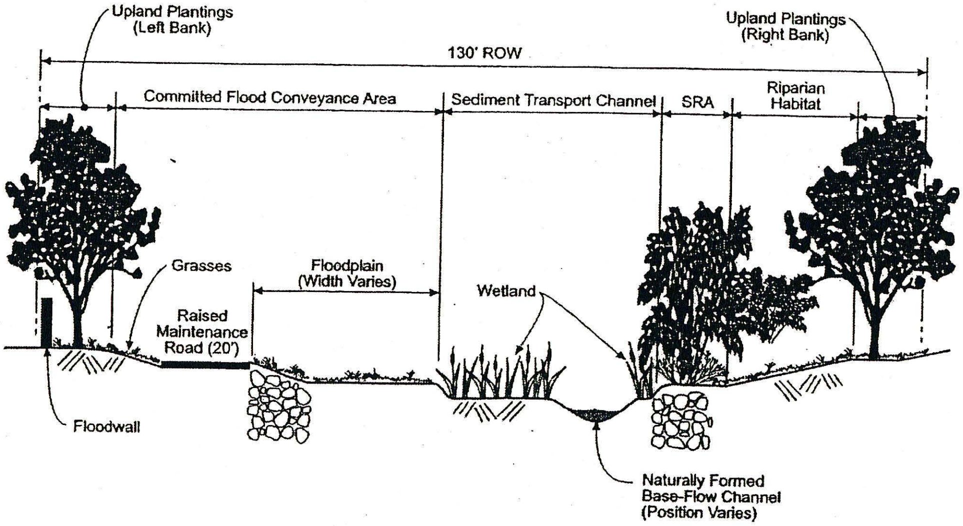
Illustrations provided below show, in a general fashion, changes that have been made to the original improvement plans. The pictures compare channel geometries, habitats, depths of flow, and requisite freeboard measures. In this preliminary analysis, backwater effects due to Coyote Creek, bridges, and other structural features are not included to provide a valid comparison of channel plans. Unfortunately, the NRCS plans are not tied to any physical datum, so it is nearly impossible to verify water surface elevations relative to natural grade.

These pictures are illustrative only, and are not to scale. Actual channel geometries and design details may vary, but the concepts are true to form.


Trees, Shrubs & Vines
Intermittent tree clusters this side of low flow channel @ 50' on center (as determined by final hydraulic analysis)
@210' Right-of-Way (varies)
freeboard levee
2
1
maintenance road
@ 65' Bottom Width
15'
5'
6'
freeboard levee
emergent wetlands
Maintenance Rd. (tri-lock block)
3' deep Base-Flow Channel & Emergent Wetlands
willow fascines

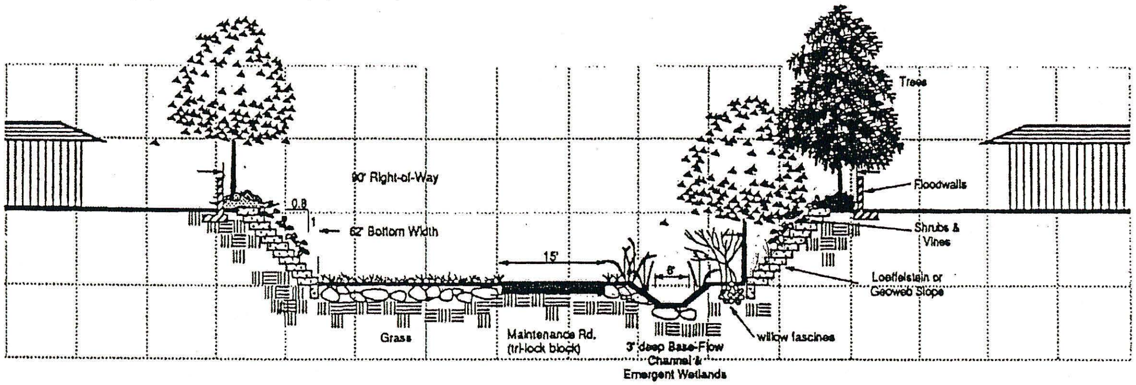
NRCS Reach 1A

Flow Depth = 15.75 feet; freeboard levees

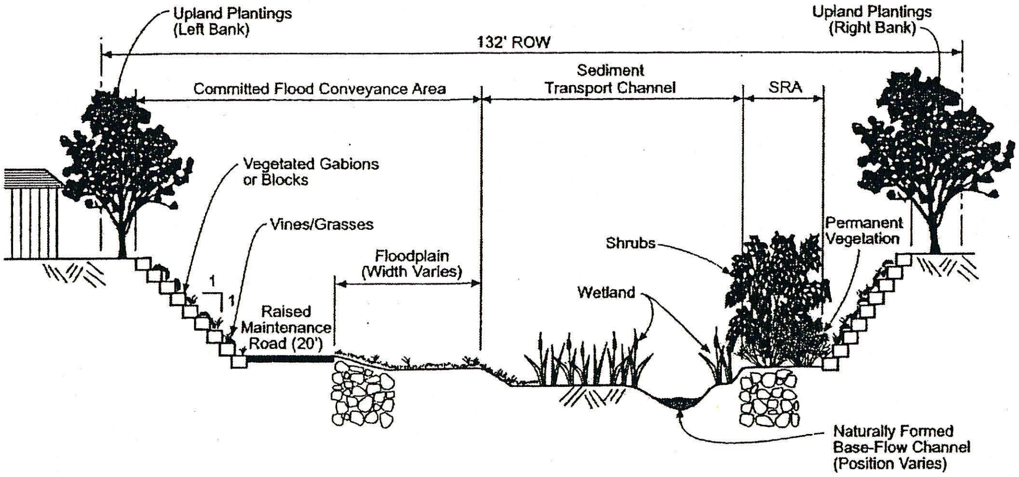

Upland Plantings (Left Bank)
Upland Plantings (Right Bank)
130' ROW
Committed Flood Conveyance Area
Sediment Transport Channel
SRA
Riparian Habitat
Grasses
Floodplain (Width Varies)
Wetland
Raised Maintenance Road (20')
Floodwall
Naturally Formed Base-Flow Channel (Position Varies)

District's Refined Reach 1A

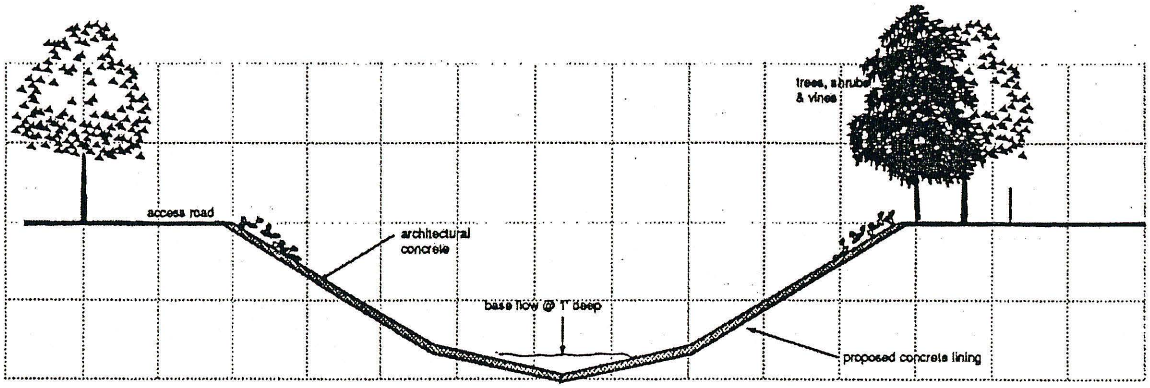
Flow Depth =15.1 feet; no levees


Trees
90' Right-of-Way
Floodwalls
0.8
1
62' Bottom Width
Shrubs & Vines
15'
6'
Loeffelstein or Geoweb Slope
Grass
Maintenance Rd. (tri-lock block)
3' deep Base-Flow Channel & Emergent Wetlands
willow fascines

NRCS Reach 1B
Flow Depth = 9.9 feet; floodwalls

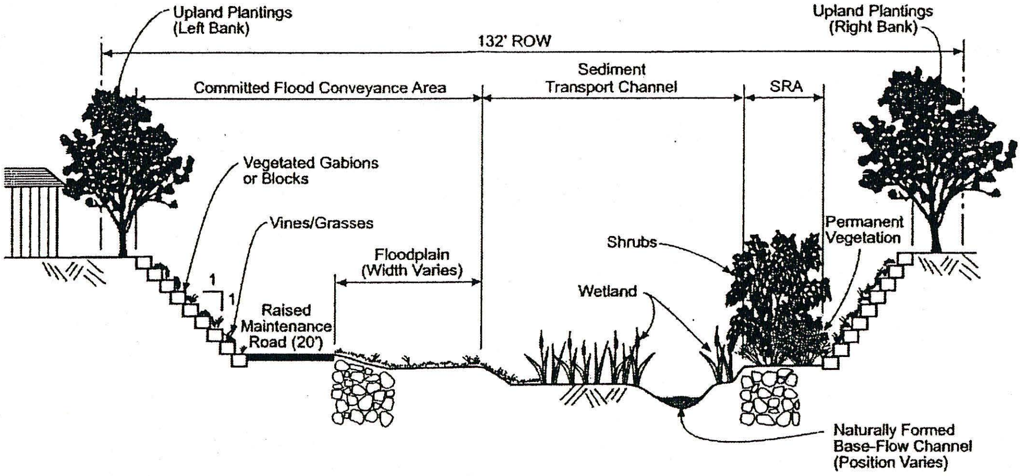

Upland Plantings (Left Bank)
Upland Plantings (Right Bank)
132' ROW
Committed Flood Conveyance Area
Sediment Transport Channel
SRA
Vegetated Gabions or Blocks
Vines/Grasses
Permanent Vegetation
Shrubs
Floodplain (Width Varies)
1
1
Wetland
Raised Maintenance Road (20')
Naturally Formed Base-Flow Channel (Position Varies)

District's Refined Reach 1B
Flow Depth = 10 feet; no floodwalls



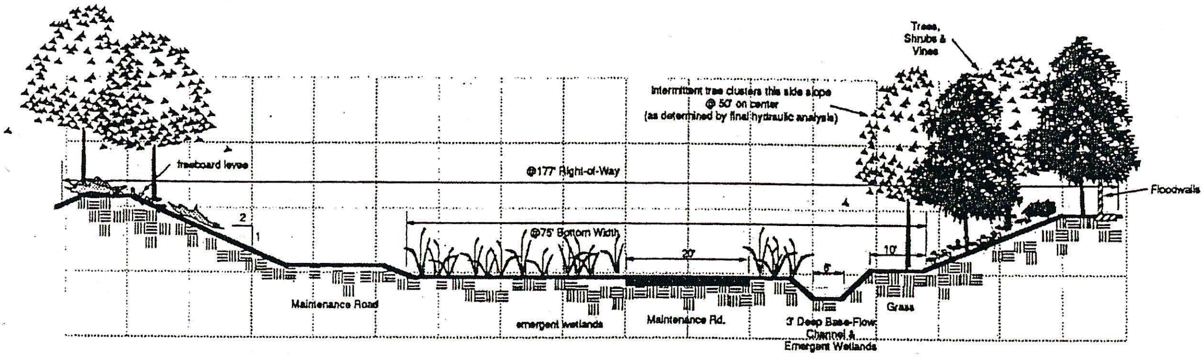
NRCS Reach 1C

Flow Depth = 12.8 feet; No floodwalls shown

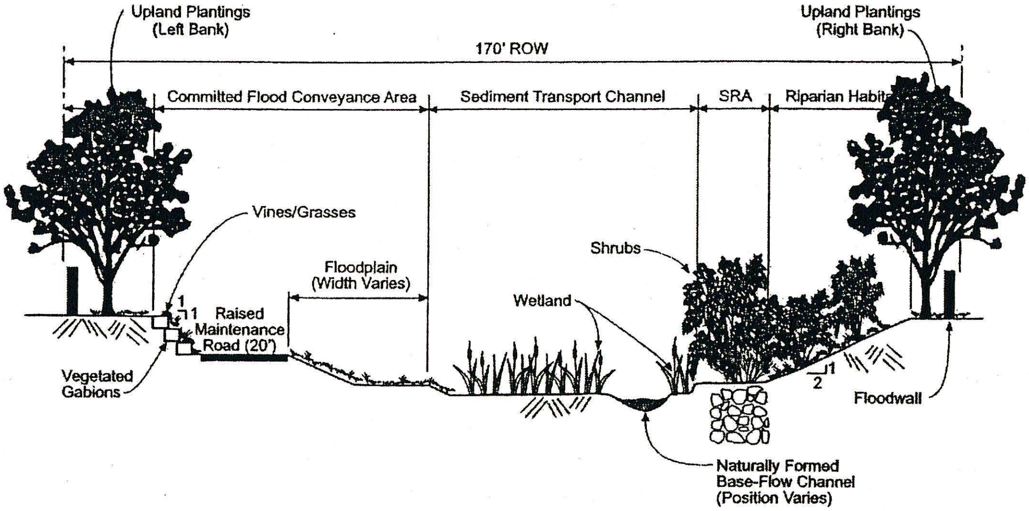

Upland Plantings (Left Bank)
Upland Plantings (Right Bank)
132' ROW
Committed Flood Conveyance Area
Sediment Transport Channel
SRA
Vegetated Gabions or Blocks
Vines/Grasses
Floodplain (Width Varies)
1
1
Raised Maintenance Road (20')
Shrubs
Wetland
Permanent Vegetation
Naturally Formed Base-Flow Channel (Position Varies)

District's Enhanced Reach 1C

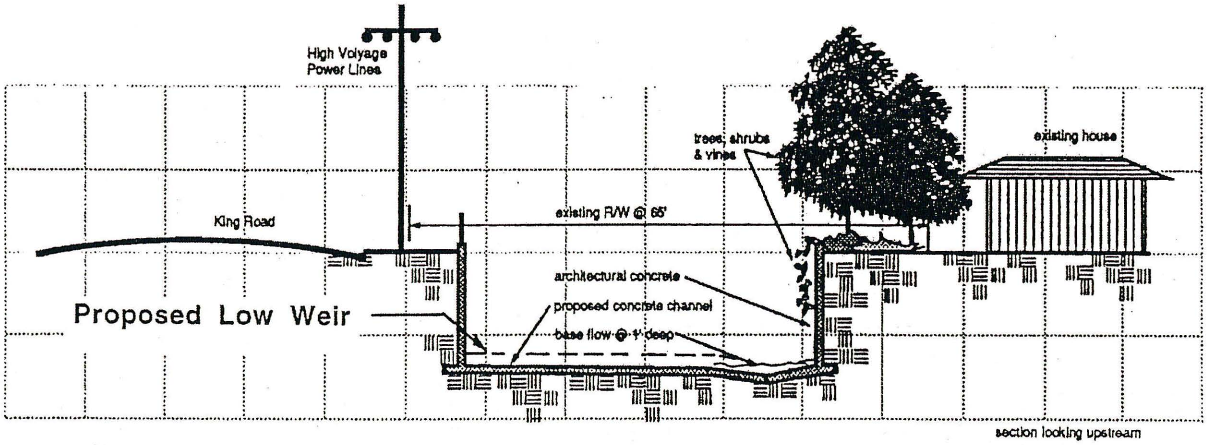
Flow Depth = 13.5 feet; Floodwalls as required


Trees, Shrubs & Vines
Intermittent tree clusters this side slope @ 50' on center (as determined by final hydraulic analysis)
freeboard levee
@177' Right-of-Way
Floodwalls
2
1
@75' Bottom Width
20'
5'
10'
Maintenance Road
emergent wetlands
Maintenance Rd.
3' Deep Base-Flow Channel & Emergent Wetlands
Grass

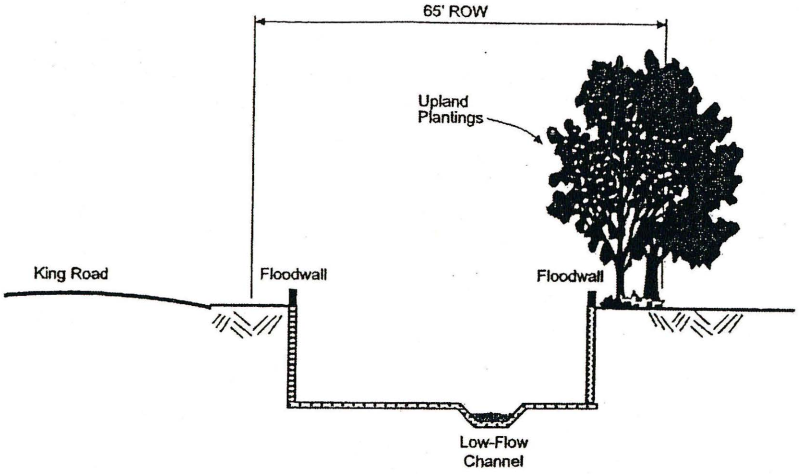
NRCS Reach 1D
Flow Depth = 13.0 feet; Freeboard levees and floodwalls


Upland Plantings (Left Bank)
Upland Plantings (Right Bank)
170' ROW
Committed Flood Conveyance Area
Sediment Transport Channel
SRA
Riparian Habit
Vines/Grasses
Floodplain (Width Varies)
Shrubs
Wetland
1
1
Raised Maintenance Road (20')
Vegetated Gabions
1
2
Floodwall
Naturally Formed Base-Flow Channel (Position Varies)

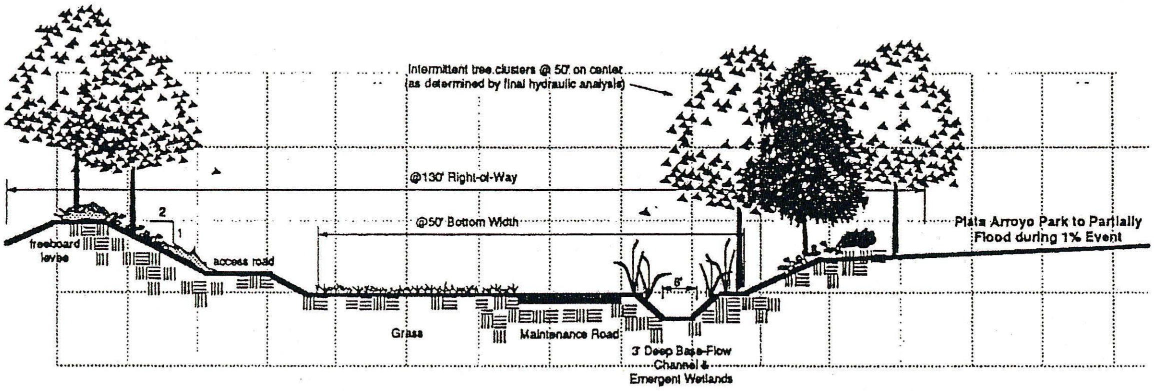
District's Refined Reach 1D
Flow Depth = 13.5 feet; Floodwalls as required



NRCS Reach 2
Flow Depth = 11.7 feet; U-frame wall extensions

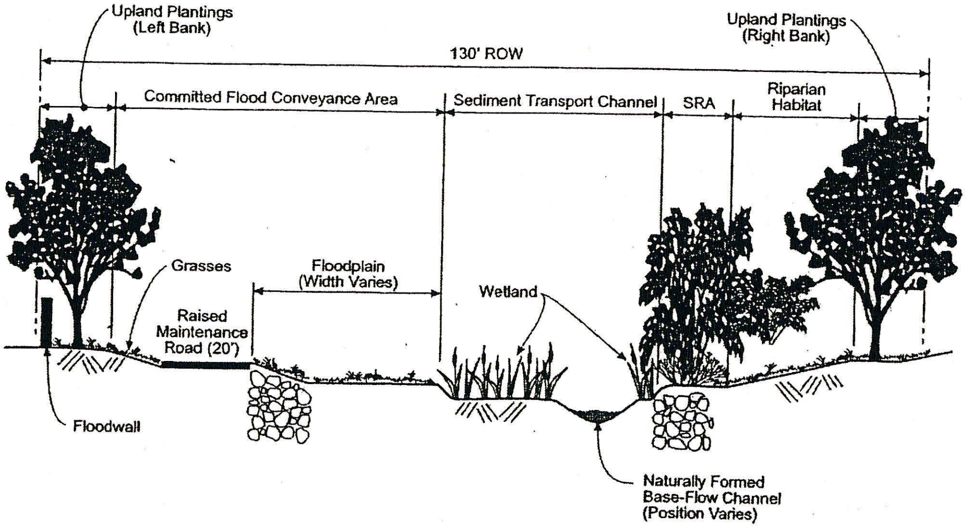


District's Refined Reach 2
Flow Depth = 13.0 feet; U-frame wall extensions
(Additional depth is from Reach 1D backwater NRCS did not consider)


Intermittent tree clusters @ 50' on center
(as determined by final hydraulic analysis)
@130' Right-of-Way
@50' Bottom Width
2
1
freeboard levee
access road
Grass
Maintenance Road
6'
3' Deep Base-Flow Channel & Emergent Wetlands
Plata Arroyo Park to Partially Flood during 1% Event

NRCS Reach 3A

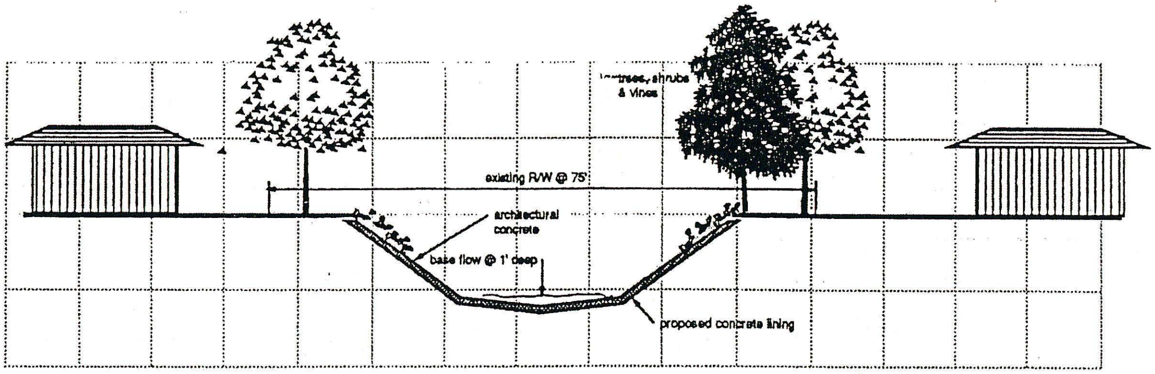
Flow Depth = 10.8 feet; Freeboard levees left bank


Upland Plantings (Left Bank)
Upland Plantings (Right Bank)
130' ROW
Committed Flood Conveyance Area
Sediment Transport Channel
SRA
Riparian Habitat
Grasses
Floodplain (Width Varies)
Raised Maintenance Road (20')
Wetland
Floodwall
Naturally Formed Base-Flow Channel (Position Varies)

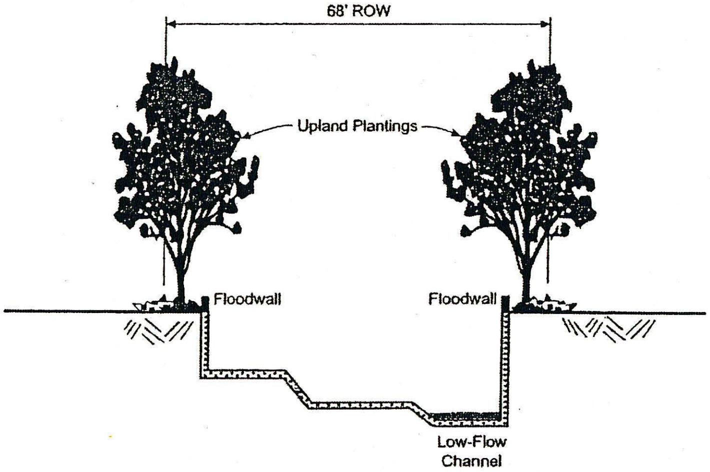
District's Refined Reach 3A

Normal Depth = 10.9 feet; Floodwalls left bank

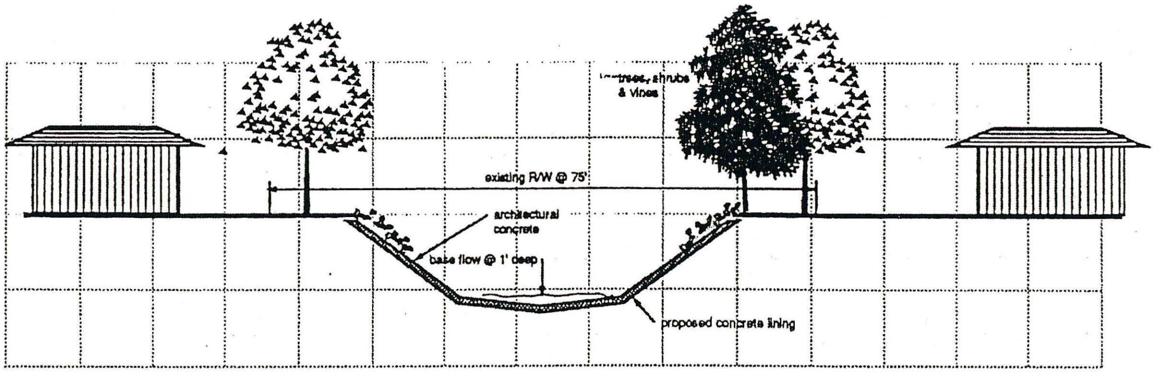
McKee Road culvert backwater controls in this reach, however, flow depth = 14.6 feet.



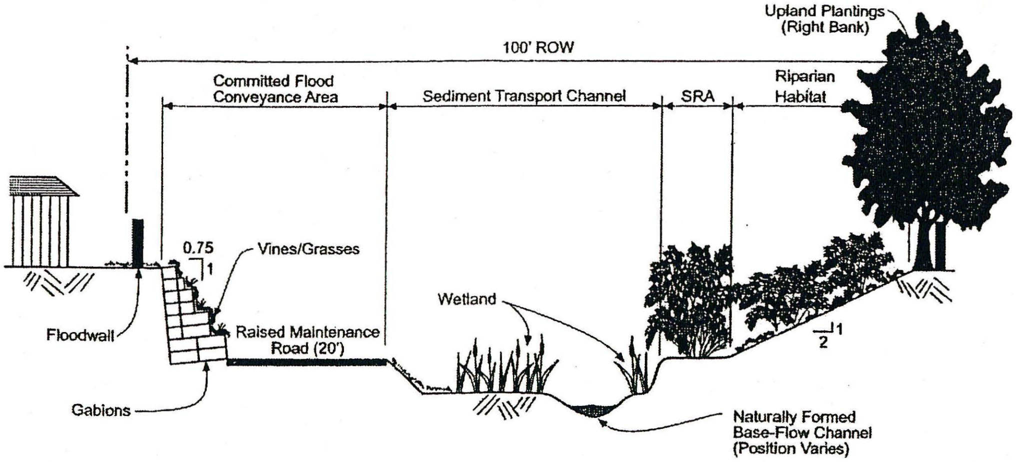
NRCS Reach 3B/C
Flow Depth = 9.8 feet, No floodwalls.



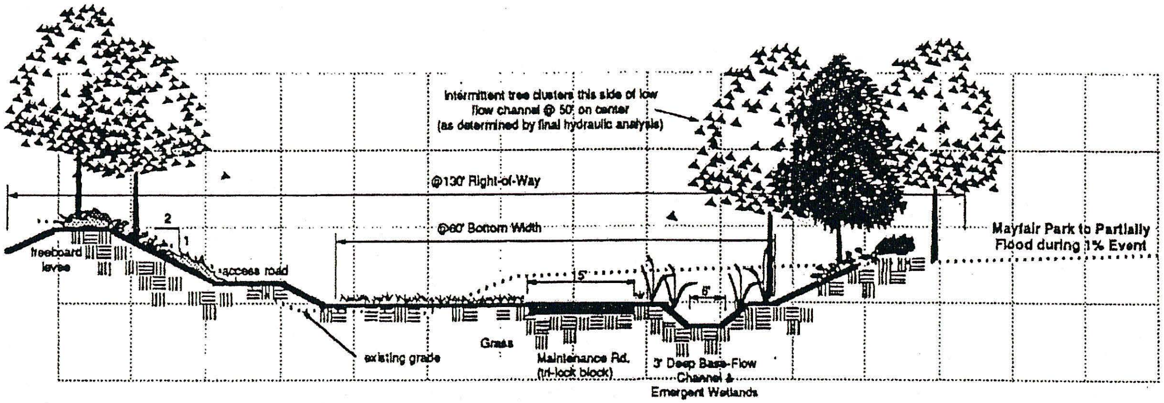
District's Refined Reach 3B/C
Normal Depth = 11.0 feet, U-frame wall extensions as required.
McKee Road culvert backwater controls in this reach, however, flow depth up to 13 feet.



NRCS Reach 3C/D
Flow Depth = 9.8 feet, No floodwalls.

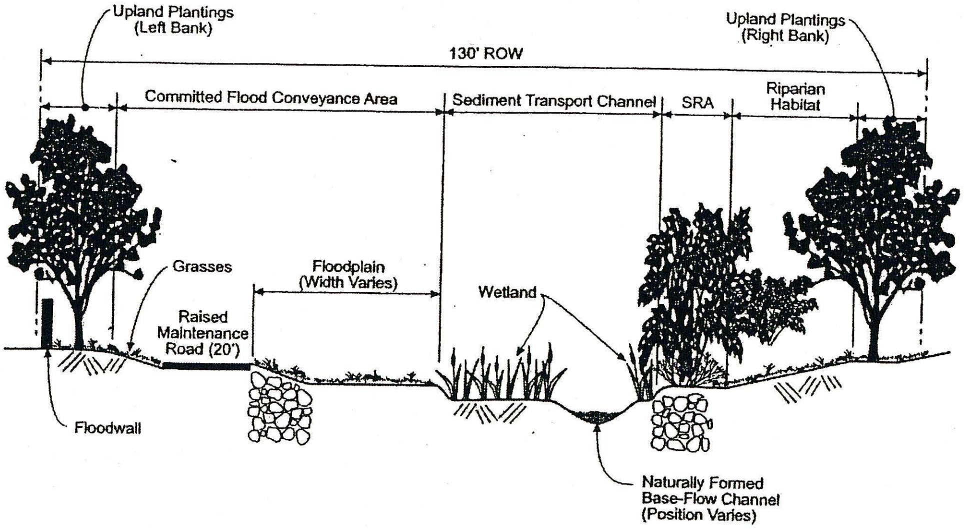


District's Enhanced Reach 3D
Flow Depth = 10.2 feet; No floodwalls.


Intermittent tree clusters this side of low flow channel @ 50' on center (as determined by final hydraulic analysis)
@130' Right-of-Way
@60' Bottom Width
2
1
freeboard levee
access road
15'
6'
Mayfair Park to Partially Flood during 1% Event
existing grade
Grass
Maintenance Rd. (tri-lock block)
3' Deep Base-Flow Channel & Emergent Wetlands

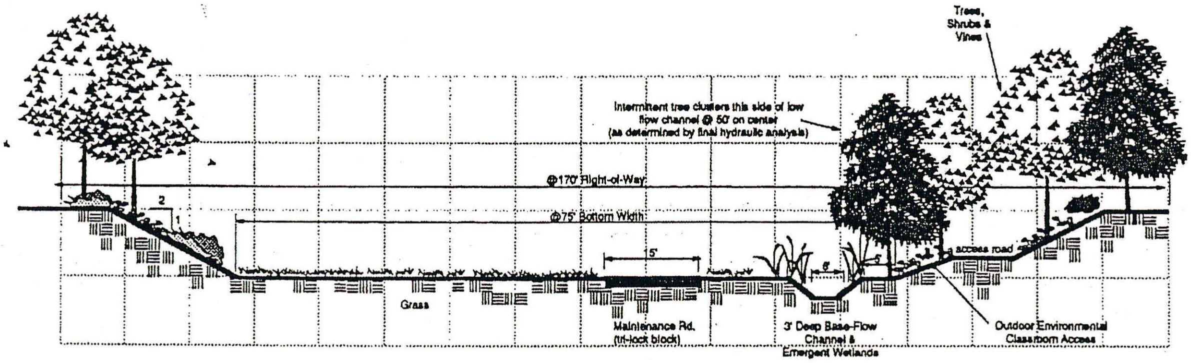
NRCS Reach 3E

Flow Depth = 12.4 feet, Freeboard levee left bank.


Upland Plantings (Left Bank)
130' ROW
Upland Plantings (Right Bank)
Committed Flood Conveyance Area
Sediment Transport Channel
SRA
Riparian Habitat
Grasses
Floodplain (Width Varies)
Raised Maintenance Road (20')
Wetland
Floodwall
Naturally Formed Base-Flow Channel (Position Varies)

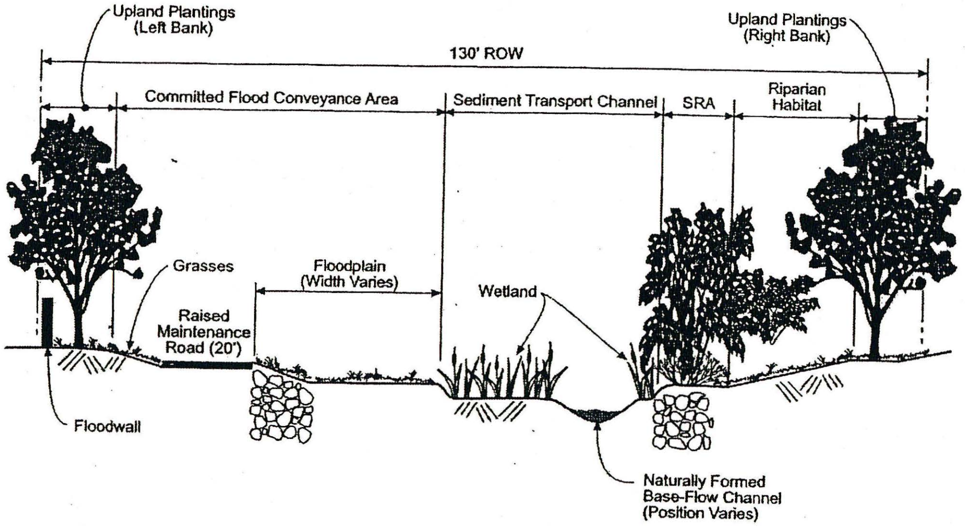
District's Refined Reach 3E

Flow Depth = 10.6 feet, Short freeboard wall left bank.


Trees, Shrubs & Vines
Intermittent tree clusters this side of low flow channel @ 50' on center (as determined by final hydraulic analysis)
Φ170' Right-of-Way
Φ75' Bottom Width
2
1
5'
6'
5'
access road
Grass
Maintenance Rd. (tri-lock block)
3' Deep Base-Flow Channel & Emergent Wetlands
Outdoor Environmental Classroom Access

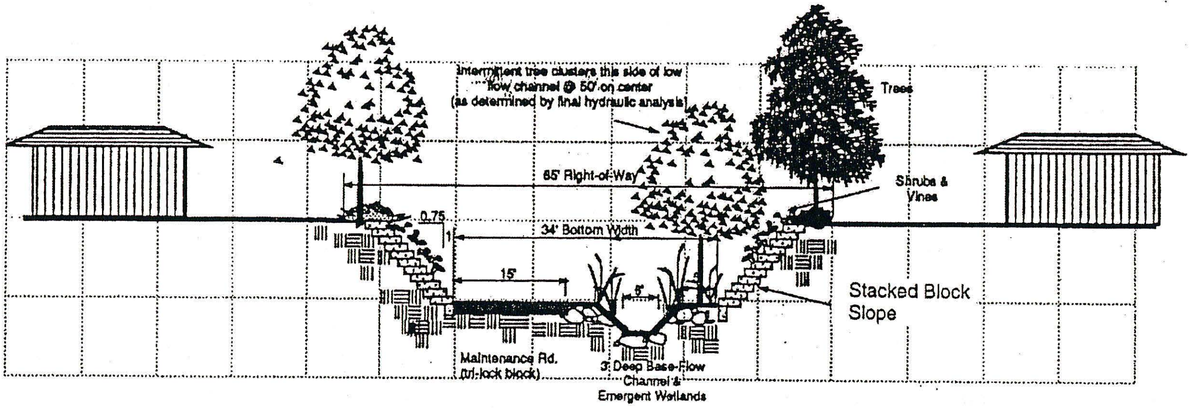
NRCS Reach 3F

Flow Depth = 12.4 feet.


Upland Plantings (Left Bank)
Upland Plantings (Right Bank)
130' ROW
Committed Flood Conveyance Area
Sediment Transport Channel
SRA
Riparian Habitat
Grasses
Floodplain (Width Varies)
Raised Maintenance Road (20')
Wetland
Floodwall
Naturally Formed Base-Flow Channel (Position Varies)

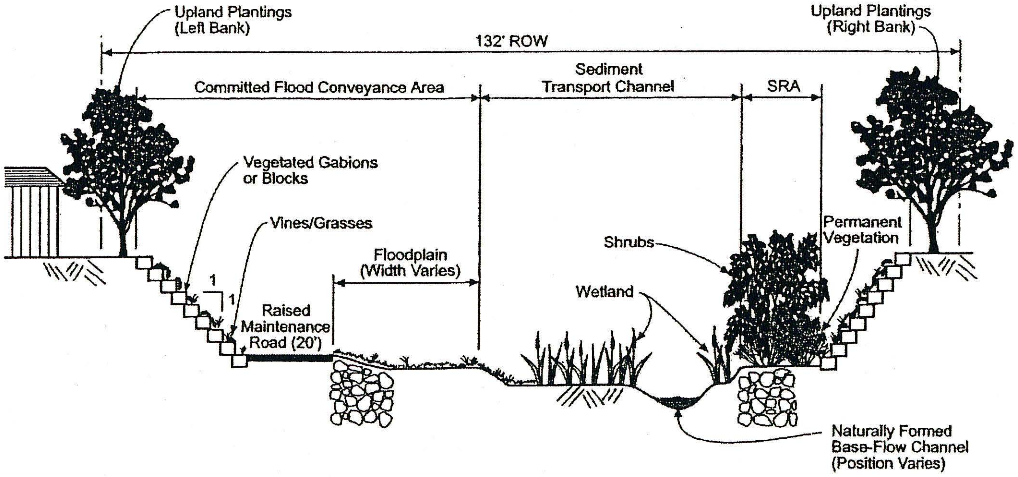
District's Refined Reach 3F

Flow Depth = 9.5 feet, Short freeboard wall left bank.


Intermittent tree clusters this side of low flow channel @ 50' on center (as determined by final hydraulic analysis)
Trees
65' Right-of-Way
Shrubs & Vines
0.75
1
34' Bottom Width
15'
5'
Stacked Block Slope
Maintenance Rd. (tri-lock block)
3' Deep Base-Flow Channel & Emergent Wetlands

NRCS Reach 4

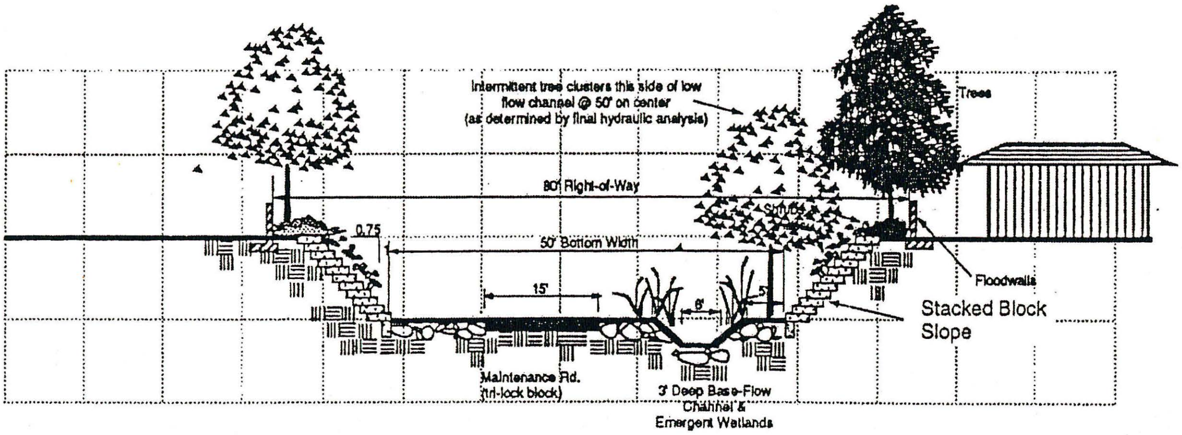
Flow Depth = 9.9 feet. Floodwalls on both banks.


Upland Plantings (Left Bank)
Upland Plantings (Right Bank)
132' ROW
Committed Flood Conveyance Area
Sediment Transport Channel
SRA
Vegetated Gabions or Blocks
Vines/Grasses
Floodplain (Width Varies)
1
1
Raised Maintenance Road (20')
Shrubs
Permanent Vegetation
Wetland
Naturally Formed Base-Flow Channel (Position Varies)

District's Refined Reach 4

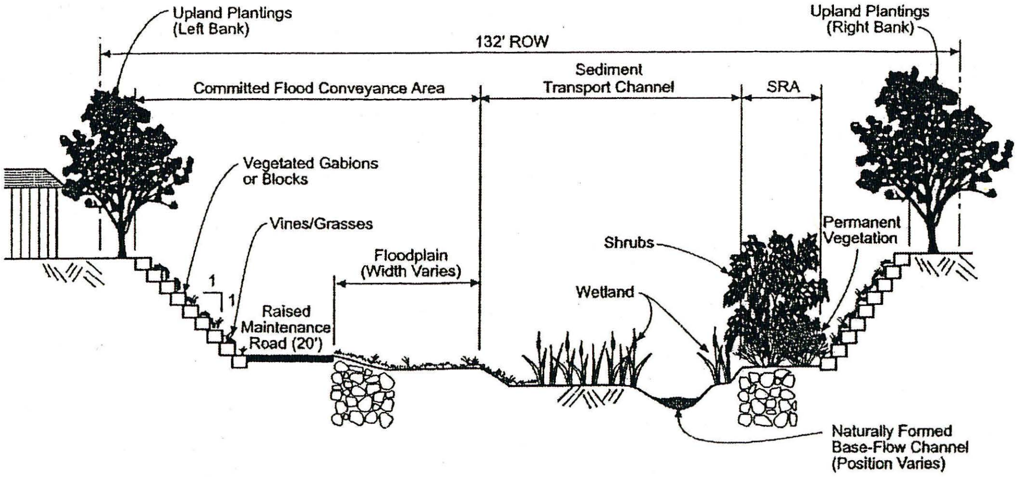
Normal Depth = 8.8 feet. Floodwalls required in backwater area only (800 LF)

Flow Depth = 11.8 feet due to backwater from Interstate 680 culvert.


Intermittent tree clusters this side of low flow channel @ 50' on center (as determined by final hydraulic analysis)
Trees
80' Right-of-Way
Shrubs
0.75
50' Bottom Width
15'
6'
5'
Floodwalls
Stacked Block Slope
Maintenance Rd. (tri-lock block)
3' Deep Base-Flow Channel & Emergent Wetlands

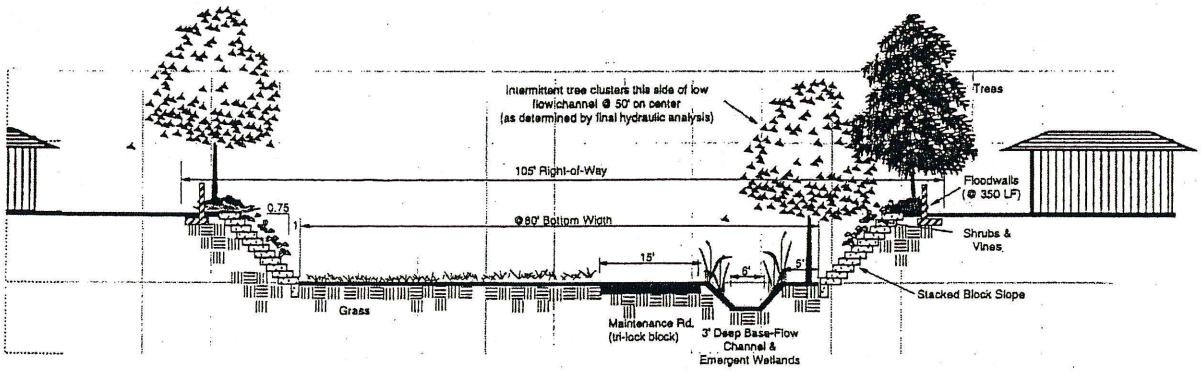
NRCS Reach 5

Flow Depth up to 11 feet. Floodwalls on both banks.


Upland Plantings (Left Bank)
132' ROW
Upland Plantings (Right Bank)
Committed Flood Conveyance Area
Sediment Transport Channel
SRA
Vegetated Gabions or Blocks
Vines/Grasses
1
1
Floodplain (Width Varies)
Raised Maintenance Road (20')
Shrubs
Wetland
Permanent Vegetation
Naturally Formed Base-Flow Channel (Position Varies)

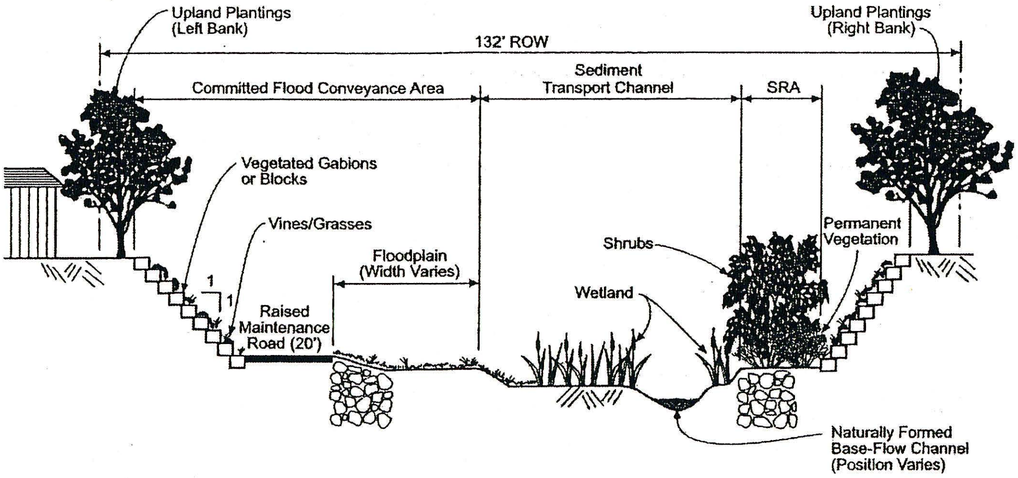
District's Refined Reach 5 (Similar to Reach 4)

Flow Depth up to 12 feet. Freeboard walls as required.


Intermittent tree clusters this side of low flowchannel @ 50' on center (as determined by final hydraulic analysis)
Trees
105' Right-of-Way
Floodwalls (@ 350 LF)
0.75
1
@80' Bottom Width
Shrubs & Vines
15'
6'
5'
Stacked Block Slope
Grass
Maintenance Rd. (tri-lock block)
3' Deep Base-Flow Channel & Emergent Wetlands

NRCS Reach 6

Flow Depth up to 11 feet. Floodwalls on both banks, Moss Point Drive to Cunningham Avenue.


Upland Plantings (Left Bank)
132' ROW
Upland Plantings (Right Bank)
Committed Flood Conveyance Area
Sediment Transport Channel
SRA
Vegetated Gabions or Blocks
Vines/Grasses
Floodplain (Width Varies)
Shrubs
Permanent Vegetation
1
1
Raised Maintenance Road (20')
Wetland
Naturally Formed Base-Flow Channel (Position Varies)

District's Refined Reach 6 (Similar to Reach 5)

Flow Depth up to 12 feet. Floodwalls on both banks from Ocala Avenue to Cunningham Avenue.

BRIDGE REPLACEMENT

As stated previously, the 1983 NRCS update plans appear to be based on normal depth calculations with no backwater effects due to Coyote Creek, bridges, or other transitions. Under that assumption, the one-percent water surface is carried at or near the natural banks of Lower Silver Creek, as is the case with the refined District plans. Floodwalls and levees would primarily be constructed to meet District freeboard criteria, and would be on the order of no more than about three feet above natural ground. As discussed in this chapter, however, bridges and other structures can have a significant impact on water surface elevations, and to the point where bridge and culvert improvements are necessary to avoid excessively high floodwalls.

Table 5-1 presents a step-wise backwater analysis that looks at the effects of rehabilitating individual bridges beginning downstream at Wooster Avenue, which is currently scheduled for replacement by the City of San Jose. Bridges are recommended for improvement or replacement if the one-percent energy loss through them is sufficient to raise floodwall heights above four feet as measured from nearest adjacent grade, or if there are other compelling aesthetic or economic concerns as explained herein. Bridges off limits to replacement for economic or other reasons include the Western Pacific Railroad, U.S. Highway 101, McKee / King Road, and Interstate 680.

Table 5-1: Stepwise Bridge Replacement Matrix

Bridge Location	Existing Bridge Structures		Replace?	With New Bridge Structures	
	1% WSEL	U/S Floodwall Height		1% WSEL	U/S Floodwall Height
Wooster Avenue	84.83	N/A	Per CSJ	84.93	N/A
Walgreens	88.17	1.8’	NO		
Alum Rock Avenue	107.52	15.5’	**YES**	92.77	N/A
Sunset Avenue	99.39	5.4’	**YES**	95.93	N/A
San Antonio Street	99.84	0.8’	NO		
Jackson Avenue	110.41	8.4’	**YES**	106.81	5’
Capitol Expressway	120.95	9.5’	**YES**	111.86	N/A
Story Road	124.32	3’	**YES**[1]	123.51	2’
Murtha Drive	125.63	N/A	NO		
Moss Point Drive	128.00	N/A	NO		
Ocala Avenue	128.37	3’	NO		

[1] At planners’ discretion to reduce upstream floodwall costs.

REACH BY REACH EVALUATION

Design one-percent water surface profiles are included in this Chapter. Appendix E contains numeric information including design water surface elevations, channel velocities, freeboard requirements, and Froude Number (channel stability) for both extremes of channel roughness. Within the following paragraphs, design freeboard and hydraulic stability are addressed. Channel cross sections referenced in this report are oriented looking upstream.

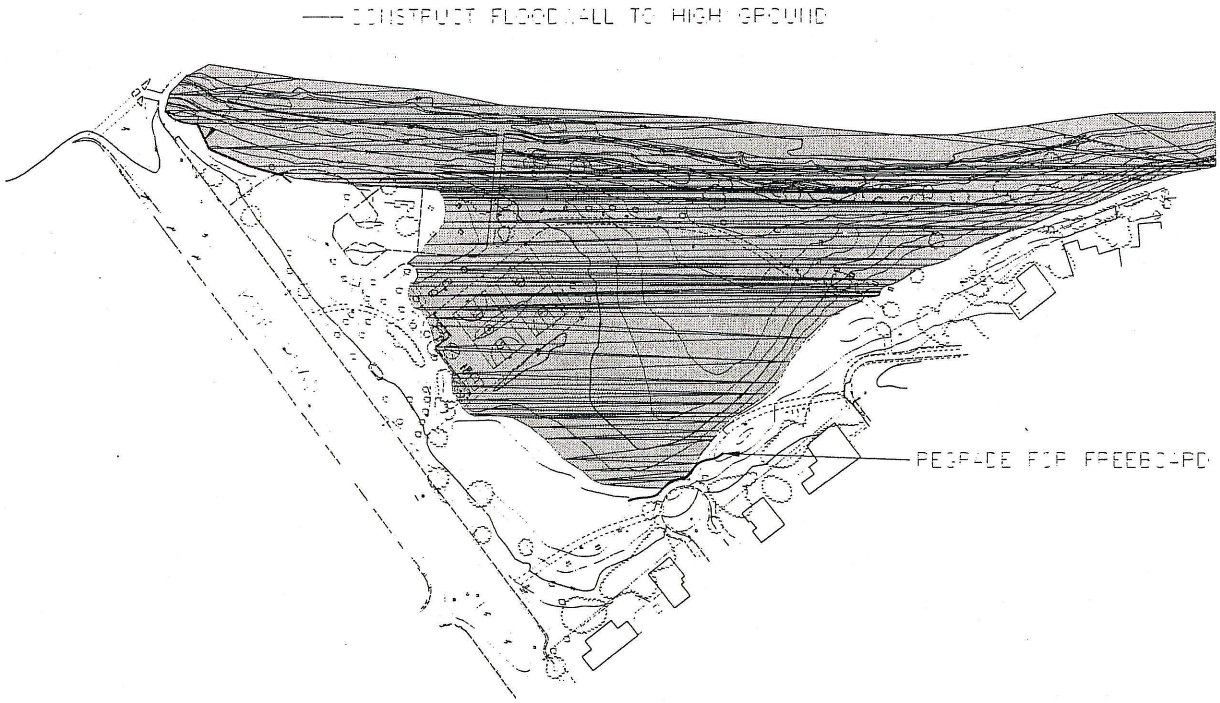
Reach 1. Coyote Creek to Miguelita Creek (Station 0+73 to Station 38+50)
From the confluence with Coyote Creek to Highway 101, the right bank of Lower Silver Creek provides a means for upstream Coyote Creek spills to re-enter the Silver Creek / Coyote Creek system. Therefore, levees or floodwalls should not be constructed along the right bank of Lower Silver Creek until a future Coyote Creek project is completed. The design one-percent water surface elevation assuming coincident flow in Coyote Creek is contained by the natural banks everywhere in this reach between Station 7+00 to Highway 101, with the exception of approximately 100 feet upstream from Station 15+20, where the natural right bank is roughly 0.3 foot too low. Below Station 7+00, the right overbank is also a part of the Coyote Creek overbank, and this area will continue to be flood prone after project completion.

Upstream of Highway 101 the design one-percent water surface elevation is contained by natural grade everywhere except for the left bank between Stations 22+00 and 23+00, where the design water surface is 0.2 foot above the ground surface. To meet FEMA and District/NRCS freeboard criteria, a floodwall is necessary along both banks between the freeway and the new Walgreens Bridge downstream of McKee Road. The top of wall elevation should be a straight grade beginning at elevation 90 feet NAVD at the upstream face of the Highway 101 Bridge, terminating at an elevation of 91 feet NAVD at the Walgreens Bridge in Reach 2. Floodwall heights, as measured from adjacent grade, will vary from approximately six inches to 3.2 feet at a maximum. Average wall height in this reach is roughly two feet.

Reach 2. Miguelita Creek to McKee Road (Station 38+50 to Station 52+35)
At the low range of Manning's roughness values, channel velocities could approach 10 feet per second but Froude numbers remain less than 0.6, indicating stable subcritical flow. The energy grade line is fully contained by proposed floodwalls or natural ground throughout this reach. Predicted superelevation at the tightest curve (a radius of 313 feet) within the 46-foot wide U-frame channel in Reach 2 is less than 3 inches, and still below the natural bank elevation.

Reach 3. McKee Road to Interstate 680 (Station 54+30 to Station 125+00)
Backwater from the constriction formed by the McKee Road culvert influences the design water surface profile upstream to Alum Rock Avenue. Because of this backwater, District levee freeboard criteria will govern the design of floodwalls. Floodwaters will be allowed to back up into the Plata Arroyo Park. 100-year floodwater should inundate the basketball courts and most of the park itself, and will release to Melrose Street unless a small area along the edge of the park is regraded to contain the floodwater as shown in Figure 5-1.

Figure 5-1: Plata Arroyo Inundation



Proposed bridge replacements at Alum Rock Avenue and Sunset Avenue enable the design water surface elevation to be carried well below natural grade with adequate freeboard, even under potentially supercritical conditions (low "n") in the concrete lined portions of this reach. Floodwalls are not required from Station 82+00 to 104+50. Maximum water surface superelevation under potential supercritical flow is could reach almost one foot, but this is well below natural grade. Under subcritical flow conditions, the superelevation is limited to less than 0.2 foot.

At Alum Rock Avenue the constriction in width imposed by the existing bridge causes the severe problems presented in Table 5-1. It is possible to solve the hydraulic problems by replacing this bridge with a longer clear-span structure across the proposed 60-foot wide U-frame channel section carried upstream from Reach 3C, without the need to raise its soffit elevation. It must be emphasized that unless the Alum Rock structure is replaced, upstream channel cannot function, and will not contain the one-percent flood with the proposed system of floodwalls.

Installing two additional 10' x 15' box culverts will rectify a similar but less extreme hydraulic constriction at Sunset Avenue. The new culvert invert will be depressed to allow for a naturally forming low-flow channel to cut itself through this reach.

At San Antonio Street, the existing bridge does not pose a hydraulic problem. To simplify the transitions to the upstream and downstream channel sections, and modify the channel invert as desired, it is recommended that the "floating" channel lining be removed and replaced with vertical walls against the abutments. The floating lining is not structurally tied to the bridge abutments or superstructure, and can be removed without compromising the bridge's structural integrity.

Between San Antonio Street and Interstate 680, freeboard walls are needed primarily along the left bank to protect the overbank where natural ground is slightly low. Floodwater will be allowed to leave the south right-of-way and encroach slightly into Mayfair Park, where the water is contained by higher ground.

If vegetation is not established prior to a large runoff event, or is removed during such an event, there is the potential for a hydraulic jump to form between Stations 123+50 and 124+50, where the unstable energy grade line would not necessarily be contained by the proposed freeboard. This is considered to be an unlikely scenario, but it does emphasize the need to provide temporary erosion protection until vegetation is established.

Reach 4. Interstate 680 to North Babb Creek (Station 128+30 to Station 170+50)
The culvert at Interstate 680 is not especially problematic, and does not pressurize when passing the design 100-year discharge. However, natural bank elevations immediately upstream of the interstate and Jackson Avenue are about a foot lower than the culvert soffit, so the design water surface profile is carried almost one foot above grade upstream of Jackson Avenue.

An 80-foot wide in-stream sediment basin with vertical walls will be established between Interstate 680 and Jackson, with access from Jackson Avenue. (As described in Chapter 2, sediments tend to accumulate within this stretch of the channel.) To minimize upstream floodwall elevations and the difficulty of removing sediments within a more complicated transition, the Jackson Avenue culvert will be replaced with a five-cell structure to match the downstream U-frame channel width. Floodwalls immediately upstream of Jackson will need to be nearly 5 feet above the lowest adjacent ground (right bank), tapering to match higher ground at Station 139+00. Between this location and Capitol Expressway, floodwalls are not needed.

The twin 12' x 12' box culverts at Capitol Expressway are inadequate to pass the design one-percent discharge, so an additional 12' x 12' box culvert will be added without disturbing the Expressway grade. Between the expressway and North Babb Creek, the one-percent water surface profile is contained by natural ground, but freeboard walls ranging in height from 1.5 to 2.5 feet are necessary. Regardless of the relative ground elevations on each bank, each floodwall must have an identical profile to provide equal levels of flood protection to each side.

Flow remains subcritical throughout Reach 4 even with a lower channel roughness assumption. Froude numbers exceed 0.8 in Reach 4C, which indicates possible flow instability. As described in Chapter 6, this sub-reach may be susceptible to erosion.

Reaches 5 and 6. North Babb Creek to Cunningham Avenue (Station 170+50 to Station 244+60)
About 140 feet of the Story Road culvert will be converted to open channel, and an additional 12-foot by 14-foot box culvert cell added to improve upstream hydraulics. Freeboard walls are needed almost to Murtha Drive, primarily on the right bank, which is two feet lower in elevation than the left bank. Between Murtha Drive and Ocala Avenue, the natural banks provide adequate freeboard. Some limited wall construction or a maximum fill of one foot is needed to provide District/NRCS freeboard on the left bank between station 224+00 and 230+00. The Ocala Avenue Bridge would not cause problems during a design runoff event, but ground elevations upstream of the bridge are three feet lower than those downstream, so floodwalls are required.

INTERIOR DRAINAGE ADJACENT TO FLOODWALLS

One major concern with the construction of floodwalls is the possibility of trapping local drainage water against the wall system, and commensurately increasing the depth of local flooding when the natural overland release to the creek is eliminated.

In general, however, Lower Silver Creek is a "perched" channel whereby drainage tends to run away from the creek rather than toward it. Field reconnaissance has confirmed this situation. For the most part, the construction of floodwalls will not adversely impact local drainage patterns, other than perhaps the back half of lots directly adjacent to the creek. Drainage systems shall be provided as needed.

Figure 5-2: Lower Silver Creek
Profiles for Reaches 1 and 2
Program Improvements w/ Bridge Replacement

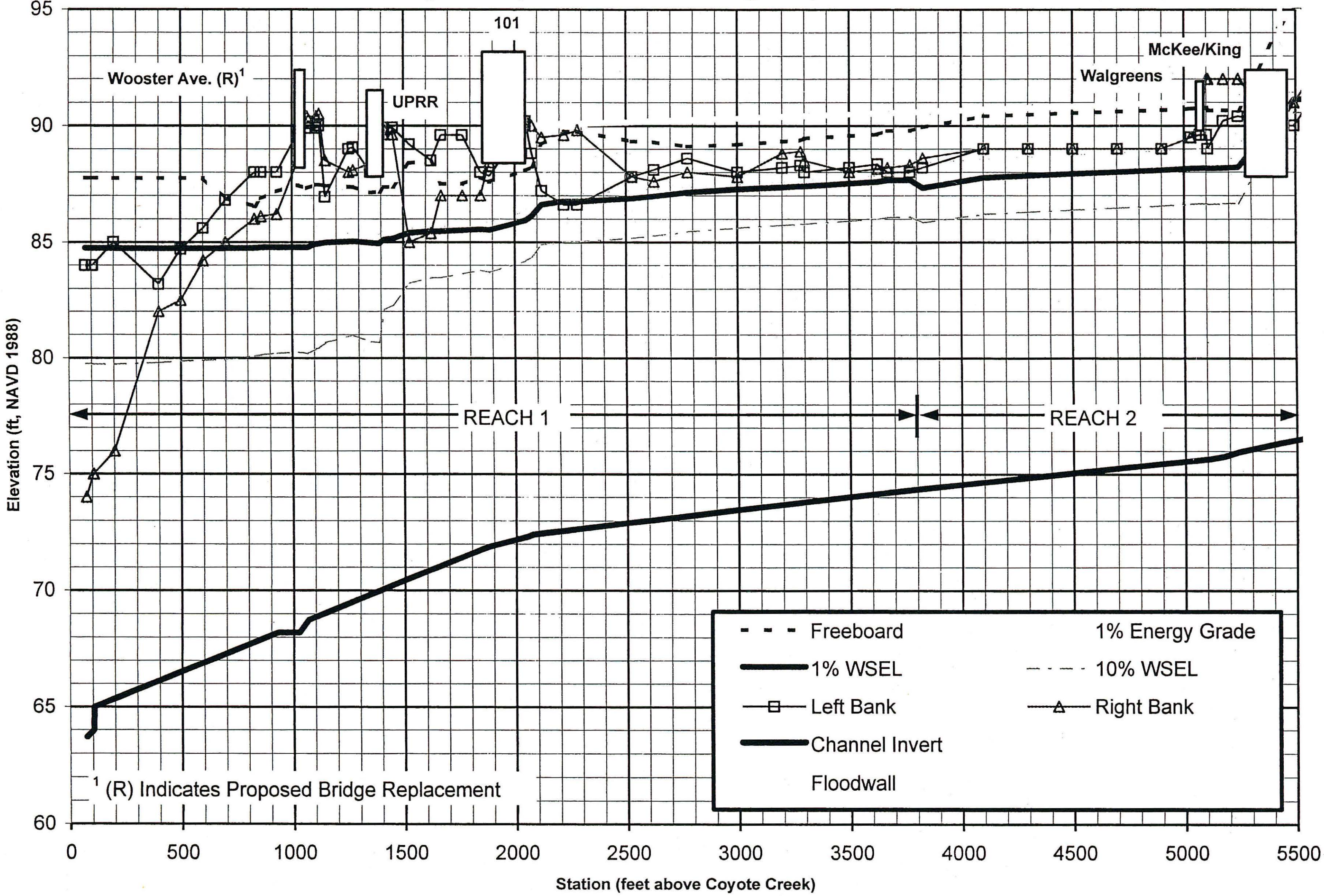
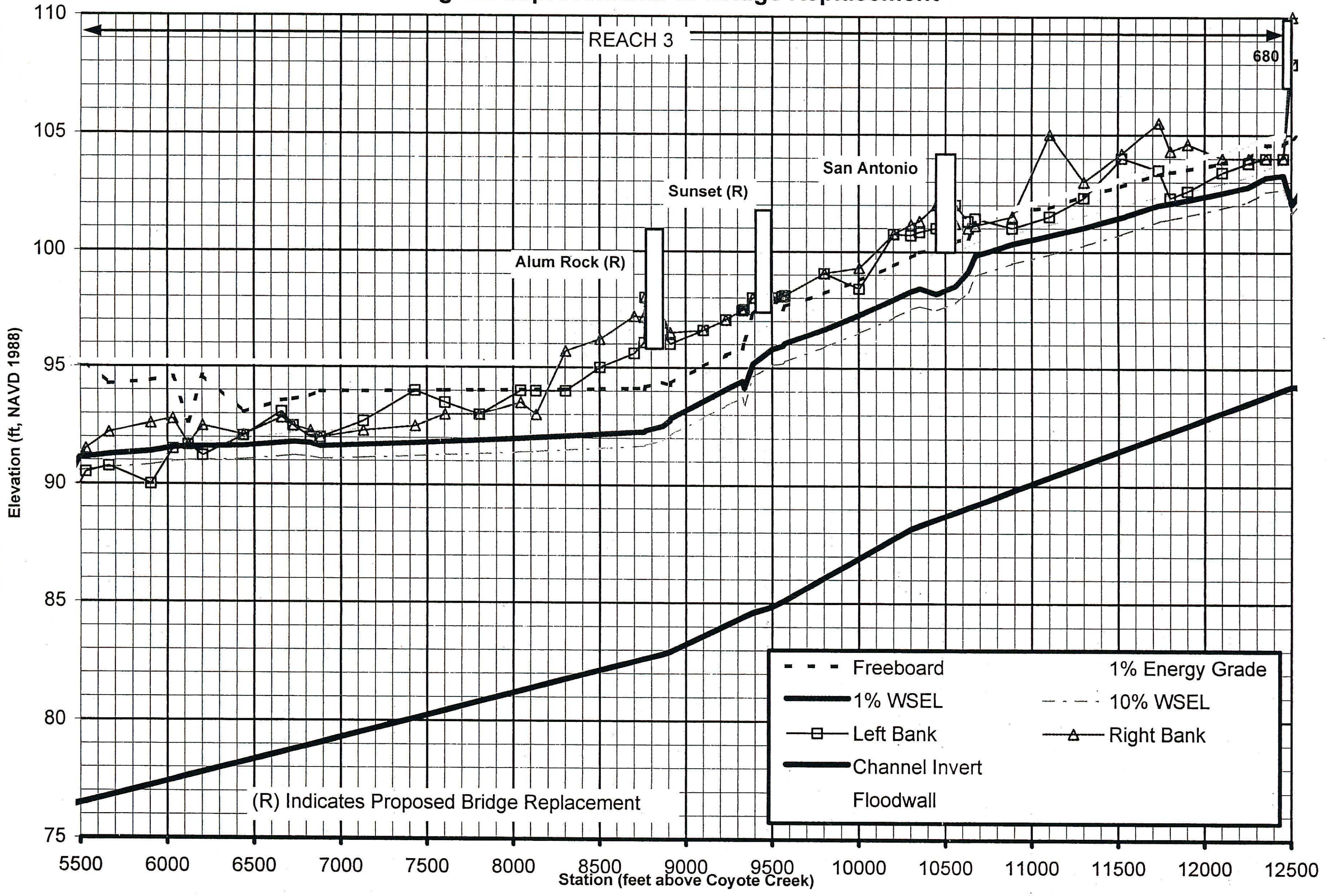


Figure 5-2: Lower Silver Creek
Profiles for Reach 3
Program Improvements w/ Bridge Replacement



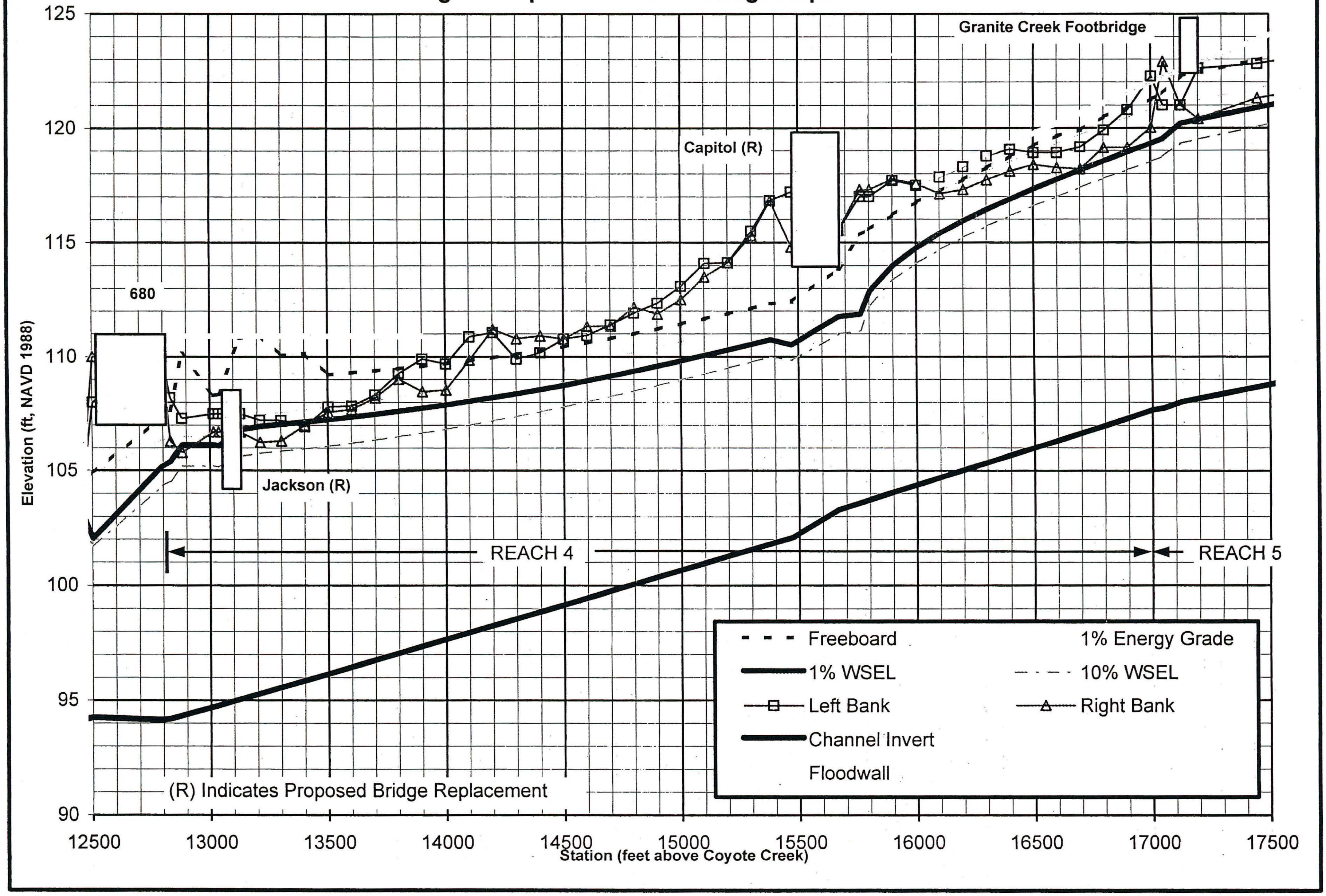


Figure 5-2: Lower Silver Creek
Profiles for Reach 4
Program Improvements w/ Bridge Replacement

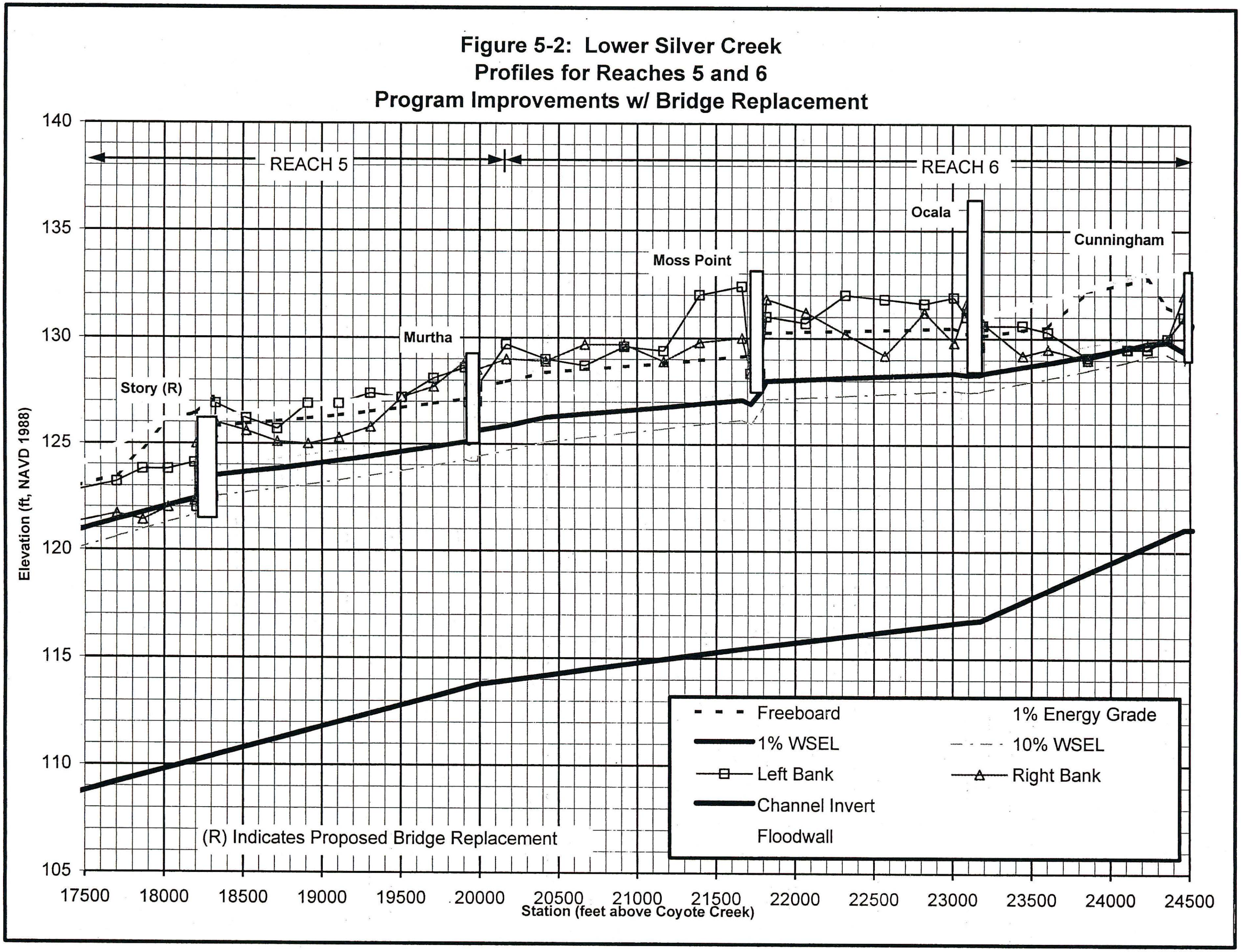


Figure 5-2: Lower Silver Creek
Profiles for Reaches 5 and 6
Program Improvements w/ Bridge Replacement

CHAPTER 6
SEDIMENT MANAGEMENT

The management of scour and sediment deposition within Lower Silver Creek may have a great impact on the future success of proposed flood protection and geomorphic improvements. This chapter addresses low-flow and extreme event sedimentation in a preliminary manner.

BASIC SEDIMENT TRANSPORT CONCEPTS

Sediment originates from the upland areas of the tributary catchments, and is transported down the natural and concrete-lined channels, with a portion of that transported sediment reaching the outfall at Coyote Creek. Significant volumes of sediment have been deposited within certain reaches of the existing creek channel as documented in Chapter 2, particularly at McKee Road, Interstate 680 and above Cunningham Avenue. If this sediment deposition is not properly managed over time, the channel will not perform as designed and could exacerbate the potential for urban flooding.

Sediment Transport Capacity

Sediment transport capacity is defined as the ability of flowing water to move sediment downstream. A variety of variables can be used to quantify the magnitude of sediment transport capacity, but the product of unit weight of water (γ), flow depth (y), flow velocity (v) and energy slope (s) has been found to be a good predictor. This product is known as the stream power per unit area, that is:

$$Stream\ Power = \gamma\ y\ \ v\ \ s$$

The impact of potential changes to a channel design on sediment transport capacity can be assessed with this equation. For example, if water is diverted out of a channel, the product of velocity, flow depth and energy slope of the flowing water remaining in the channel is likely to diminish. This implies that the sediment transport capacity of the water remaining in the channel may decrease.

Sediment Availability

Sediment availability determines, concurrently with the transport capacity, how much sediment water flowing in a stream will carry. If, for example, a stream can carry 10 pounds of sediment per second, but upstream erosion from the river bed and banks, and other sediment input make only 5 pounds of sediment per second available for transport, then the sediment carried by the stream cannot exceed 5 pounds of sediment per second. Conversely, if 10 pounds of sediment per second is available to be transported by a stream, but its sediment transport capacity is only 5 pounds of sediment per second, then only 5 pounds of sediment per second will be transported. The remainder will be deposited.

Sediment Load

Sediment load consists of wash, suspended and bed loads. Wash load is made up of very fine, colloidal particles such as clay, that often remain in suspension even when the sediment transport capacity of the water reduces significantly. Suspended load consists of fine sediment particles, and can settle onto the riverbed or flooded overbank areas if the sediment transport capacity of the water reduces enough. Most of the sediments found in Lower Silver Creek fall into this category. Bed load is coarser material that moves along the riverbed as flowing water drags it along. It ceases to move as the sediment transport capacity of the water diminishes.

If flow in a channel is large enough to overtop its banks, the bed load usually remains in the main channel, while the suspended and wash load are contained in the water column over the main channel and in the water column over the flooded overbank area. The sediment transport capacity in the main channel is often large enough to maintain suspension of the suspended load within this water column, but it can reduce enough in the flooded overbank area to deposit the suspended sediment (and sometimes even the wash load).

Maintenance Flow

A typical natural cross section of a stream consists of a main channel and an overbank (also known as a floodplain). Research and field observations over many years suggest that the water discharge capacity of the main channel (i.e. the volume of water that it can discharge per second when it flows full to the edge of its bank) is equivalent to approximately the two-year recurrence interval flow. When the discharge in the stream exceeds this flow magnitude, it overtops its banks with water flowing onto the floodplain.

LOW-FLOW REGIMES

Annual sediment management is primarily concerned with sediment transport behavior for low-flow events. One of the Program's goals is to provide for naturally occurring sediment transport within significant reaches of the unlined channel. This portion of the report addresses sedimentation during low-flow events and examines the potential for annual sediment loading from influent tributaries.

Sediment Transport Channel

An unlined sediment transport channel has been proposed as a mechanism for providing natural deposition and scour in Lower Silver Creek. As a natural phenomenon, the quantitative geomorphologic behavior of this channel is unpredictable, but since its size and slope will not be significantly different than the existing channel section, past geomorphology is likely to be a good predictor of future conditions, assuming that the average climate remains about the same.

Photographs from Chapter 2 provide one predictor of sediment transport channel behavior. For the most part, the existing low-flow channel is straight with some slight meandering in certain reaches. Sediment deposits at the fringes of the open water support emergent wetland vegetation. Significant accumulations of sediment and more extensive vegetation are seen just upstream of the McKee Road Bridge, Interstate 680, and Cunningham Avenue.

Table 6-1 provides an assessment of minimum discharges required to initiate bed particle movement within the sediment transport channel on a reach-by-reach basis. (For a point of reference, the design depth of the transport channel will vary from 2.5 to 3.0 feet depending upon the reach.) Since the minimum estimated two-year discharge is 600 cfs, there should be some transport of sediment in all reaches at least every other year. At District direction, a roughness coefficient of 0.04 is assumed for this analysis. Based on grain size distributions for sediment near Lake Cunningham, the largest particle size that needs to be transported downstream is approximately 2mm, which represents large sand. The critical velocity for incipient sediment motion is calculated as:

$$V_c = K_u \, y^{1/6} \, D^{1/3}$$

where V_c = critical velocity to transport sediment of size D and smaller
y = average depth of flow
D = median particle size (2 mm)
K_u = 11.17 (dimensionless)

Table 6-1: Threshold of Discharge for Sediment Transport

Reach	Transport Channel Width	Threshold Discharge for Transport	Depth of Flow at Incipient Motion
1A, B	28 feet	60 cfs	0.9 foot
1C, D	50 feet	500 cfs	3.5 feet
3A	30 feet	250 cfs	2.5 feet
3D	26 feet	60 cfs	1.0 foot
3E,F	26 feet	80 cfs	1.3 feet
4B	49 feet	150 cfs	1.3 feet
4C	21 feet	50 cfs	1.1 feet
5	21 feet	120 cfs	2.0 feet
6A	56 feet	525 cfs	3.6 feet
6B	31 feet	80 cfs	1.1 feet

Stream Slope Stability

Without detailed knowledge of the sediment supply from the Lake Cunningham area or tributary creeks, a preliminary slope stability analysis has been made using a tractive force analysis to estimate the equilibrium slope where bed material movement ceases:

$$S_{eq} = \left[K_s D_c \left(\frac{\gamma_s - \gamma}{\gamma} \right) \right]^{(10/7)} \left(\frac{K_u}{qn} \right)^{(6/7)}$$

where S_{eq} = Channel slope at which particles D_c will no longer move
q = Discharge per unit width
K_s = Shield's Parameter
K_u = 1.486
n = Manning roughness coefficient = 0.020 as a worst case
D_c = Critical bed material size = D_{90}
γ = Unit weight of water = 62.4 pounds per cubic foot
γ_s = Unit weight of sediment = 165 pounds per cubic foot (specific gravity = 2.65)

The critical size of sediment used in this equation is D_{90} because the streambed will coarsen (armor itself) as degradation occurs. Sediment sizes are based on gradation curves provided by Parikh Consultants, Kleinfelder, and Geotechnical Consultants for soil borings taken near the depth of the finished channel invert. Long-term slope stability is predicated upon the "dominant discharge," which is typically considered to be the two-year flow.

The Shield's Parameter is a function of bed shear and sediment size:

$$U_{*,c} = \left(\frac{\gamma \text{ d S}}{\rho} \right)^{1/2}$$

where $U_{*,c}$ = Shear velocity (feet per second)
γ = Specific weight of water = 62.4 pounds per cubic foot
d = Depth of flow (feet)
S = Energy gradient (foot per foot)
ρ = Density of water (1.94 slugs per cubic foot)

The boundary Reynolds Number is:

$$R_* = \frac{U_{*,c}\, d_c}{\upsilon}$$

where $U_{*,c}$ = Shear velocity (feet per second)
d_c = critical bed material size (feet)
ν = kinematic viscosity of water = 0.00001 feet squared per second

Shield's diagram published by ASCE (Sedimentation Engineering, 1975), is used to obtain K_s. The specific gravity of streambed material is assumed to be 2.65 in all calculations. Appendix E provides a table listing equilibrium slopes calculated within each reach, together with a maximum expected depth of upstream degradation, and recommended spacing of channel stability measures that would limit maximum long-term depth degradation to three feet, which is the desired depth of the naturally forming low flow channel. The analysis provided in Appendix E is based on hard maintenance floors at the following bridges or channel sections:

Coyote Creek
Highway 101
Reach 2
McKee Road
Reach 3B
Sunset Avenue
Interstate 680
Jackson Avenue
Capitol Expressway
Story Road
Moss Point Drive
Cunningham Avenue

Calculations show that maximum predicted long-term degradation could be up to 7 feet without additional grade stabilization measures. Although it is not analytically possible to include the effects of the cohesive soils on-site, additional five-foot deep cutoff walls installed at the following locations are recommended to minimize the potential for long-term invert degradation:

Station 7+00
Station 14+00
Station 105+00
Station 115+00
Station 139+00
Station 147+00
Station 165+00
Station 173+00
Station 194+00
Station 205+00
Station 227+00
Station 236+00

SOURCES OF ADDITIONAL SEDIMENT

If the channels that deliver runoff from Tully Road to Cunningham Avenue are utilized as sediment retention facilities as planned, then the inflow of bed-load sediment to Lower Silver Creek should be limited to its downstream tributaries. Based on previous statistical analyses performed by Schaaf & Wheeler for the District's Norwood Creek and Flint Creek debris basins, the average annual debris and sediment loading factor is about 650 cubic yards per tributary square mile per year. This statistic is for rural areas, and if the factor is applied to the rural tributaries of South Babb, North Babb, and Miguelita Creeks, these annual debris loadings might be expected:

South Babb Creek	3.4 mi^2	2,200 CY/year
North Babb Creek	1.1 mi^2	800 CY/year
Miguelita Creek	1.8 mi^2	1,200 CY/year

Predicting the average amount of sediment that will actually reach Lower Silver Creek is difficult, because sediment transport could be limited by the "creek" conveyance facilities through urban areas. (South Babb Creek runs in a concrete box culvert, while North Babb and Miguelita Creeks flow through concrete pipes.)

SEDIMENT TRANSPORT DURING EXTREME EVENTS

The movement of sediment during extreme runoff events has far more damage potential than the previously discussed low-flow regime transport concepts. If sediment transport is severe enough, there is the potential for catastrophic channel damage and flooding.

To assess the potential for in-channel scour and deposition, one can examine a plot of stream power against river station (Figure 6-1 at the end of this chapter). Neglecting the effects of additional sediments from Lake Cunningham and Lower Silver Creek's tributaries, this plot addresses the potential for in-channel scour and deposition during extreme runoff conditions such as the one-percent event. Increasing stream power in the downstream direction indicates a potential for **scour**, where the streamflow entrains additional sediments to balance the transport capacity, such as:

Between Story Road and Capitol Expressway
Between San Antonio Street and Sunset Avenue
Downstream of Highway 101, particularly without Coyote Creek backwater

Decreasing stream power in the downstream direction indicates that the channel reach cannot carry as much sediment as upstream reaches have delivered. When sediment availability exceeds the transport capacity, the excess sediment will be **deposited**, in areas such as these:

Between Jackson Avenue and Capitol Expressway
Sunset Avenue Culvert
McKee Road to Alum Rock Avenue (backwater from McKee Road Culvert)
McKee Road Culvert

Detailed watershed assessments and sediment transport modeling would be necessary to estimate long-term sediment conditions, predict actual scour depths, or analyze sediment accumulations during a design event. These types of analyses are beyond the scope of this report.

Tractive Force Analysis

Flowing water in a channel develops forces, known as tractive forces or shear forces, acting in the direction of flow on the channel bed and sides. This average value of the tractive force per unit wetted are, or unit tractive force, is calculated as:

$$\tau_o = \gamma R S$$

where τ_0 = Unit tractive force (pounds per square foot)
▓ = Specific weight of water (62.4 pounds per cubic foot)
R = Hydraulic radius (feet)
S = Energy gradient (foot per foot)

The unit tractive force can be calculated for the flow condition of interest, and compared to the permissible unit tractive force for the type of material through which the channel is excavated. According to Chow, in a trapezoidal channel 97 percent of the unit tractive force is distributed to the bed and 75 percent of the force is distributed to the banks.

Reaches 1 through 3 of Lower Silver Creek will be excavated through cohesive material such as clay, silty clay, and sandy clay. Therefore values of permissible unit tractive forces for cohesive material as converted from USBR data on permissible velocities (Chow, 1959) are compared to actual unit tractive forces. Appendix E provides the comparison.

Permissible tractive force in a cohesive material is a function of the voids ratio and type of soil, which are obtained from soil testing results along the channel. Soils in Reaches 4 through 6 are clayey sands with gravel. Permissible unit tractive forces are a function of average particle diameter (USBR). Values for channels carrying fine sediments are assumed, with average sediment content.

Tractive force analyses in Appendix E show that if vegetation does not become well established to provide erosion protection, both the channel bed and banks will be subject to erosive velocities and will scour in the design flood event. For unlined reaches of the channel, well-established vegetation is critical to increase channel roughness and reduce the shear force. However, even with increased channel roughness, the design will rely upon vegetation to provide erosion protection, since the estimated tractive force on the banks is still greater than permissible in several reaches.

Bridge Scour

Bridge scour analyses are also beyond the scope of this report, but a detailed assessment has been made for the new Wooster Avenue Bridge under separate contract. That analysis showed the potential for a total scour depth of about 12 feet at the bridge piers under worst-case conditions. Three feet of this scour is long-term degradation (without lateral channel stability measures), with the remainder local contraction and pier scour. Order-of-magnitude estimates for local pier sour have been made at the following bridges that lack concrete protection:

Western Pacific Railroad	5 feet
San Antonio Street	3 feet

MAINTENANCE GUIDELINES

If the sediment transport channel is allowed to completely fill with sediment, the one-percent discharge is passed while leaving no less than about one-half of the design freeboard. The sediment transport channel should be inspected annually. When the average depth of sediment is to within approximately one foot of the level of the maintenance road, the sediment should be removed to original grade. Any sediment that remains on the maintenance road will begin to compromise freeboard and eventually one-percent flood protection.

Figure 6-1: Lower Silver Creek
Sediment Transport Capacity for Reaches 1 and 2
Program Improvements w/ Bridge Replacement

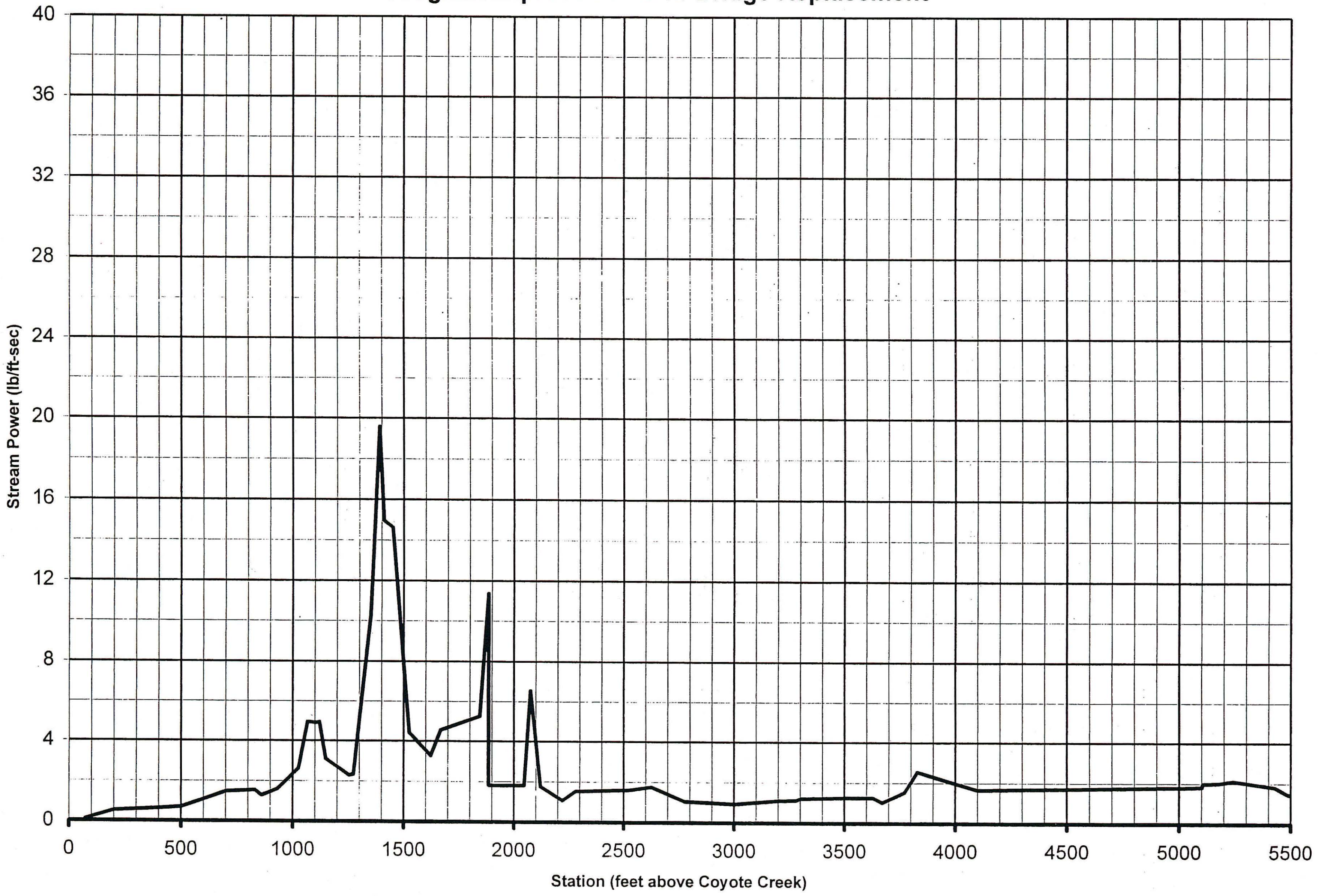


Figure 6-1: Lower Silver Creek
Sediment Transport Capacity for Reach 3
Program Improvements w/ Bridge Replacement

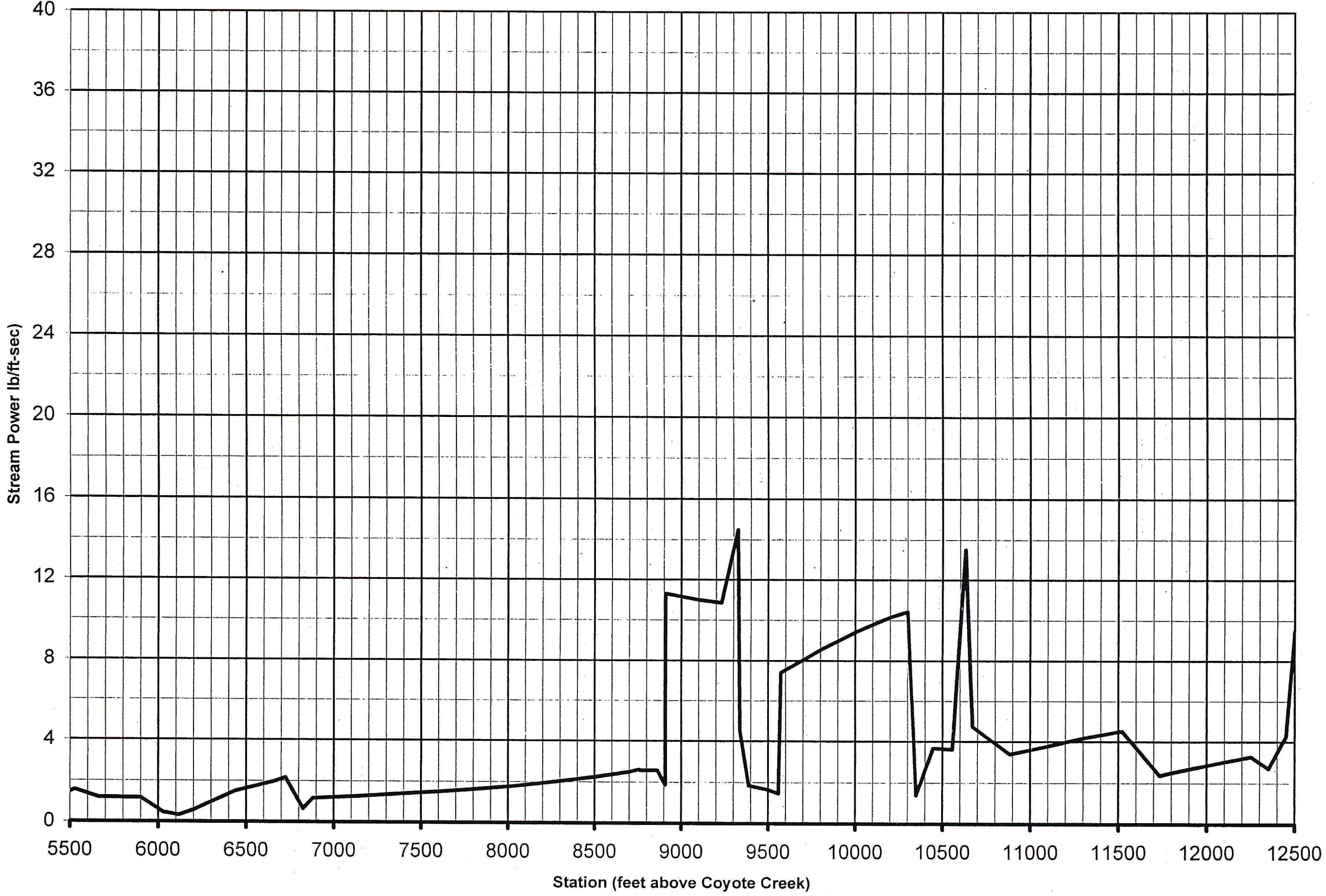
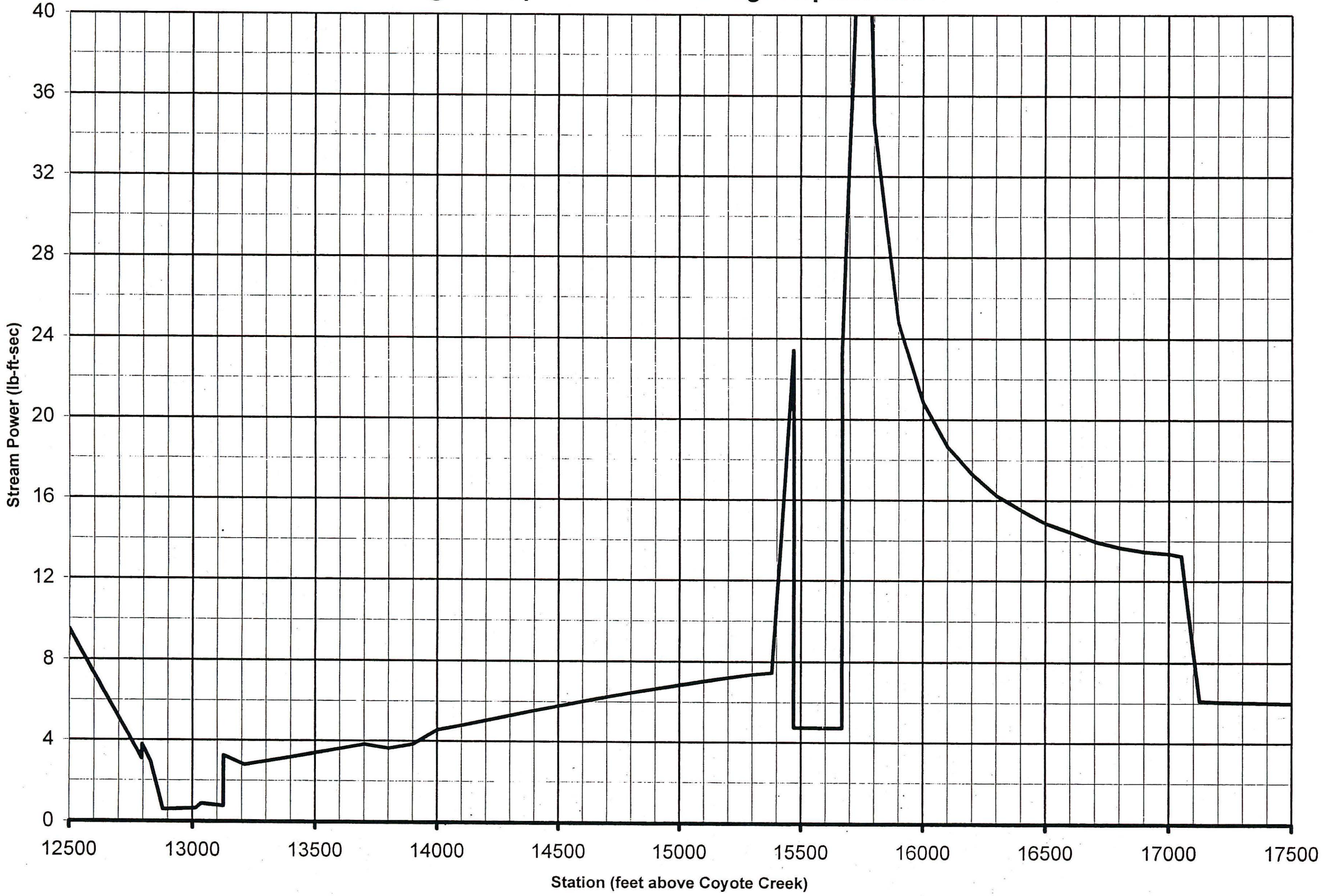


Figure 6-1: Lower Silver Creek
Sediment Transport Capacity for Reach 4
Program Improvements w/ Bridge Replacement



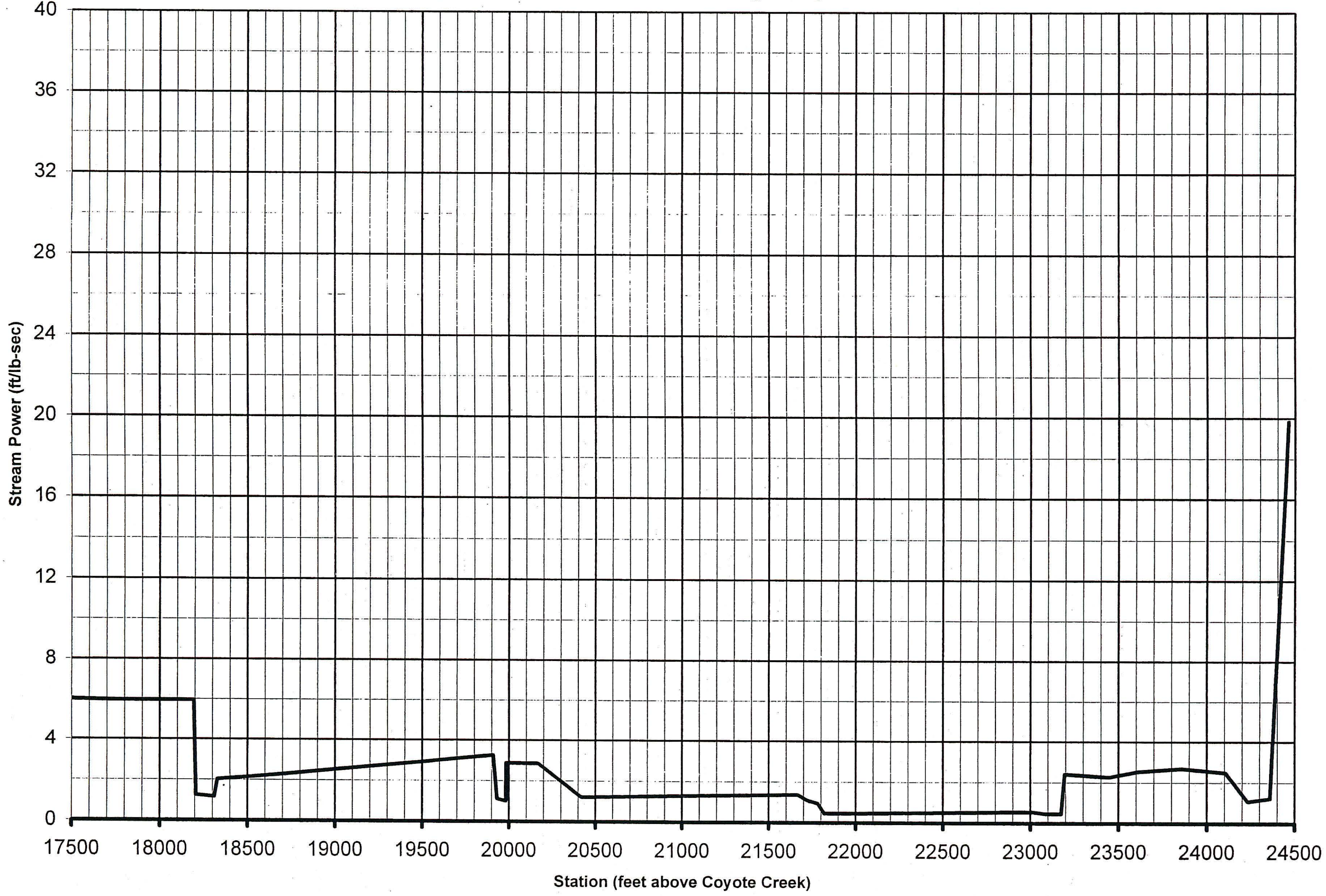


Figure 6-1: Lower Silver Creek
Sediment Transport Capacity for Reaches 5 and 6
Program Improvements w/ Bridge Replacement

Degradation	The geologic process by which stream and river beds lower in elevation. It is the opposite of *aggradation*.
Design Flow	The magnitude of streamflow (see *discharge*) that is used in design of channel modifications and structures across channels.
Discharge	The volume of water passing through a channel during a given period of time. Usually measured in cubic feet per second.
District	Santa Clara Valley Water District.
El Niño	A disruption of the ocean-atmosphere system in the Tropical Pacific having important consequences for weather and climate around the globe. An El Niño tends to increase rainfall across the southern tier of the United States. The 1997-1998 El Niño was very strong, and caused destructive flooding throughout Northern California.
FEMA	Federal Emergency Management Agency.
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
Floodplain	An area of land inundated by *floodwaters*. Floodplains may consist of standing or moving water.
Floodwaters	Those flows of water that cannot be contained within the natural stream channel.
Freeboard	Vertical distance between the top of an embankment adjoining a channel and the water level in the channel. It is a factor of safety designed into a project.
Gravel	Sediment particles larger than sand and ranging from 0.25 to 3 inches in diameter.
Hydraulic Jump	The transition of flow from the *supercritical* to the *subcritical* condition; the change characterized by turbulence and energy loss.
Hydrograph	A plot of *discharge* (flow) against time.

Inlet Control	Flow through a bridge, culvert, or pipe where the upstream water surface elevation is determined only from the geometric characteristics of the entrance to the structure.
Low Flow Channel	A subchannel of the main stream channel that is designed to concentrate low flows for biological or aesthetic reasons.
NAVD	Adjusted vertical datum of 1988. Generally 2.75 to 2.9 feet higher than NGVD in project area.
NGVD	The *mean sea level* in 1929. National Geodetic Vertical Datum.
NFIP	National Flood Insurance Program.
NPDES	National Pollutant Discharge Elimination System.
100-Year Flood	The *one-percent flood*.
1% Flood	A flood magnitude that has a one percent chance of being equaled or exceeded in any one year.
Ordinary High Water	The area of a watercourse subject to Section 404 of the Federal Clean Water Act of 1972. The area affected is determined by the elevation of the 2.3-year flood event (ordinary high water flow) which is field checked by biologists using physical characteristics.
Outlet Control	Flow through a bridge, culvert, or pipe where the upstream water surface elevation is determined from the downstream water elevation and/or energy losses through the structure and its entrance.
Overbank	In a river or creek, the area between the main channel and the limits of the *floodplain*.
Overflow	*Floodwater* that leaves a channel over its bank(s).
Pressure Flow	Flow under pressure through a tube, such as formed by a pipe, bridge deck, or culvert. Opposite of open channel flow where there is a free surface.
Reach	A subdivision of the creek for convenience of study and reference.

Riparian	Vegetation and wildlife living within, and immediately adjacent to a river, stream or lake. In this report, riparian means the creek environment.
Roughness	Represents the frictional resistance of a surface to the flow of water. Used in hydraulic computations. Also, Manning's "n".
Sacked Concrete Slope Protection (SCSP)	Burlap bags filled with concrete and placed on a stream bank to protect the bank against erosion.
SCVWD	Santa Clara Valley Water District.
Sequent Depth	Corresponding water depths upstream and downstream of a *hydraulic jump*, also known as conjugate depth.
Soffit	The underside of a bridge deck, or the top of a box culvert. If the water surface elevation is at or above the soffit, *pressure* flow or *inlet* control may occur.
Subcritical Flow	Flow conditions in which a wave from a disturbance moves upstream. Also known as Tranquil Flow. See also *backwater.*
Supercritical Flow	Flow conditions in which a wave from a disturbance moves downstream. Also known as Rapid Flow. Supercritical flow conditions can lead to high velocities and shock wave formation at the location of channel geometry changes.
Suspended Load	The part of the total sediment load that is carried for a considerable period of time at the velocity of the flow, free from contact with the streambed. See also *bed load.*
Wash Load	The part of the *suspended load* comprised of very fine, colloidal particles such as clay.
Watershed	The geographical region or area drained by a stream. Also referred to as a drainage basin or tributary.
Wetlands	As used herein, areas that under normal circumstances have hydrophytic vegetation, hydric soils, and wetland hydrology.

APPENDIX B
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APPENDIX C
TECHNICAL MEMORANDA

Previous technical memoranda are included in chronological order. Technical Memoranda Nos. 2, 6, and 7 (which superceded TM6) are included in the body of this report, and are not repeated in this appendix.

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LOWER SILVER CREEK HYDRAULIC ANALYSIS

TECHNICAL MEMORANDUM: **1**

DATE: July 3, 2000

SUBJECT: ***Existing Hydrology Review and Evaluation*** (Task 2)

Purpose. The purpose of this task is to document the design discharges used by the Natural Resources Conservation Service (NRCS) in their preliminary channel design for Lower Silver Creek. Detailed hydrologic analyses within the Lower Silver Creek or Coyote Creek watersheds are not within the scope of work.

Background. Based on direction from the Coyote Watershed Program, hydraulic analysis for Lower Silver Creek shall proceed using design discharge estimates provided by the NRCS. To date, however, we have been unable to document the basis of the NRCS estimates and evaluate whether their hydrologic calculations are sufficient for submission to FEMA during the LOMR process. Therefore, NRCS estimates have been compared to design discharges provided by the Santa Clara Valley Water District (SCVWD), assuming that the District has sufficient documentation for submission to FEMA, if necessary NRCS documentation cannot eventually be located.

Summary. As Table 1 demonstrates, design discharges for both the NRCS estimates and District estimates are significantly higher than those published in the currently effective Flood Insurance Study (FIS), due to the removal of channel capacity restrictions that will result from the work on this reach of Lower Silver Creek. Since discharge values will increase by more than twenty percent, the submission of Standard Form 3 to document hydrologic analyses will be required to obtain a Letter of Map Revision. It may be noted, however, that NRCS discharge estimates vary no more than ten percent from District design values.

Additional Information Required. To more completely evaluate existing hydrology, documentation from the NRCS is required. The Coyote Watershed Program should obtain this, if it is available, prior to final design. In the meantime, discharges highlighted in bold on Table 1 will be used for preliminary channel design, to cover all bases. The channel can be designed for slightly higher discharge, and subsequently analyzed using SCVWD design discharges for application to FEMA.

TABLE 1

DISCHARGE RECONCILIATION FOR LOWER SILVER CREEK

Location	*SCVWD Point No.*	*Discharge[1] (cfs)* FIS	SCVWD	NRCS	% Δ
Cunningham Ave.	18	2,580	**3,800**	3,600	-5
Ocala Ave.	20	2,000	**3,890**	3,600	-7
S. Babb Creek	22	2,700	**4,230**	4,210	--
N. Babb Creek	23	1,500	4,480	**4,600**	+3
Interstate 680	24	2,400	4,630	**4,830**	+4
Alum Rock Ave.	25	2,400	4,720	**4,830**	+2
Miguelita Creek	27	2,300	5,180	**5,630**	+9
Highway 101	28	2,300	5,480	**5,630**	+3
Coyote Creek	29	2,670	5,480	**5,630**	+3

[1] Discharge in bold used for Prelim. Design

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LOWER SILVER CREEK HYDRAULIC ANALYSIS

TECHNICAL MEMORANDUM: **3**

DATE: July 3, 2000

SUBJECT: ***Summary of Performance Criteria*** (Task 4)

Purpose. The purpose of this task is to document hydraulic parameters to be used in channel design for Lower Silver Creek Reaches 1 through 6. This memorandum has been drafted to provide Coyote Watershed Program staff a chance to review and evaluate proposed performance criteria in advance of more detailed analysis. It is anticipated that additional memoranda may be produced when performance criteria, maintenance criteria, and mitigation planting are further clarified during preliminary and final design stages.

Hydraulic parameters for discussion include:

1) design channel roughness
2) bridge and transition losses
3) freeboard requirements
4) maintenance criteria

Channel Roughness. In one-dimensional open channel flow analysis as performed using HEC-RAS, a single parameter known as "Manning's n" factor is used to represent the retarding forces to flow imposed by the channel. Values for "n" are published in the literature, and in the absence of high water marks with which to calibrate stream reaches with known discharge, are often relied upon for channel design. When selecting roughness values for design, it is important to remember that in one-dimensional flow, Manning's "n" accounts for the flow resistance due to a host of hydraulic phenomena beyond boundary shear. These factors may include the effects of eddies, cross-waves, superelevation, bed forms, sediment and debris.

Several sources have been used to estimate roughness factors for water surface profile determination within Lower Silver Creek. These include "n" values published by Henderson (1966) and Chow (1959), engineering judgement, and procedures outlined by the Corps of

Engineers for roughness values within concrete lined channels (ASCE, 1995). Table 1 summarizes design channel roughness values of various channel elements proposed for use in hydraulic analysis.

Given the uncertainty in "n" value selection, a range of "n" values is used to examine channel performance. Lower values tend to increase channel velocity which may be important in terms of scour or wave formation. Higher values tend to maximize water depth, and will generally set freeboard requirements. For vegetal channel linings, typical "n" values for temporary erosion control materials will be used to evaluate high flow velocities. Manning's "n" values that are contingent upon maintenance conditions are so indicated.

Table 1
Proposed Manning's "n" Values for Channel Design

Element	*High "n" for depth*	*Low "n" for velocity*
Concrete Lining	0.015	0.011
Bare Earth	0.025	0.020
Erosion Control Blanket	---	0.020
Gravel Maint. Road	0.025	0.020
Open-Cell Block Pavers (No vegetation)	0.030	0.025
Open-Cell Block Pavers (w/ vegetation)	0.040	0.025
Vegetated Block Slopes	0.040	0.025
Grass Lining (Mowed to <12")	0.040	0.020
Emergent Wetland (Maintained)	0.050	0.020
Grass Lining (No maintenance)	0.060	0.020
Emergent Wetland (No maintenance)	0.100	0.020
Trees, shrubs, vines (No maintenance)	0.150	0.020
Rock Slope Protection	$0.034(d_{50})^{1/6}$	$0.034(d_{50})^{1/6}$

Bridge and Transition Hydraulics. In addition to the energy required to overcome channel resistance, structures such as bridges and culverts also cause energy losses, which can result in a raised water surface profile. Energy losses also take place in the reaches just upstream and downstream from each structure as flow contracts and expands into and out of the bridge or culvert. The following contraction and expansion coefficients for channel transitions will be used in hydraulic models (Table 2). Wherever turbulent conditions create the potential for energy loss, contraction and expansion coefficients are increased. Other transitions include channel bends, resting pools, and maintenance access ramps.

Table 2
Proposed Expansion and Contraction Coefficients

Transition Type	*Contraction*	*Expansion*	*Source*
Gradual	0.1	0.3	HEC
Warped	0.1	0.2	Chow
Wedge	0.3	0.5	Chow
Square End	0.3	0.75	Chow
Abrupt	0.6	0.80	HEC

Several methods are available through HEC-RAS to compute energy losses through the bridge itself. The "energy only" or standard step method handles a bridge section without piers in the same manner as a natural river section, except that the area between the low chord of the bridge (soffit) and the top of road is subtracted from the total cross-sectional area, and the wetted perimeter is increased where water is in contact with the bridge. Increased frictional resistance due to the added wetted perimeter is included in the energy loss through the structure. When bridge piers are present, conservation of momentum may also be applied by using a coefficient of drag, or through Yarnell's method for "Class A" low flow whereby flow through the bridge is subcritical. Table 3 provides proposed drag and pier shape coefficients for low flow bridge loss calculations.

Table 3
Proposed Pier Coefficients

Pier Shape	*Drag Coefficient*	*Pier Coefficient*
Semicircular Nose and Tail	1.33	0.90
Multiple Cylinders	1.33	1.00
Triangular Nose and Tail	2.00	1.05
Square Nose and Tail	2.00	1.25

When the computed water surface elevation is above the bridge soffit, a "pressure/weir" feature can compute losses through the structure for pressure (orifice) flow, weir flow over the top, or a combination of these. (For Lower Silver Creek, weir flow over bridges will not be allowed.) Changes to the water surface profile resulting from the bridge are calculated based on hydraulic formulae that estimate the change in energy and water surface elevation through the bridge. Other hydraulic routines are also available to perform the same function for standard culvert shapes. Coefficients of discharge for orifice flow will be evaluated on a case-by-case basis using the guidelines outlined in Table 4.

Table 4
Orifice Coefficients

Condition	*Orifice Coefficient*
Orifice in Thick Wall (typical bridge)	0.80
Submerged, square-edged	0.80
Submerged, well-rounded	0.90
Increase in C per number of contracted sides	0.04

A side of a bridge orifice is considered to be contracted if it is located close to the bottom or side wall of the creek channel, whereby the approaching flow is guided so that the orifice contraction is suppressed on those sides of the orifice close to such guides. Clear-span bridges across trapezoidal or U-frame (rectangular) channels are examples of orifices contracted on three sides.

Freeboard. The use of design "freeboard" provides a measure of safety that compensates for the many unknown and difficult-to-quantify parameters that affect the calculation of flood elevations. These factors include uncertainty in rainfall data, soil loss parameters, watershed urbanization, wave action, debris at bridge openings, and general uncertainties in hydrologic and hydraulic procedures. Freeboard is usually expressed in terms of feet above the design base flood elevation. To meet FEMA standards, freeboard is necessary whenever a levee system is used to provide flood protection. NFIP regulations define a levee as a "man-made structure, *usually* an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding." [emphasis added] Structural floodwalls, although not earthen, are included in FEMA's definition of a levee system.

When mapping flood-prone areas, FEMA only recognizes those levee systems meeting the following minimum design criteria [NFIP §65.10(b)]:

> (1) Freeboard. (i) Riverine levees must provide a minimum of three feet above the water-surface level of the base flood. An additional one foot above the minimum is required within 100 feet in either side of structures (such as bridges) riverward of the levee or wherever the flow is constricted...
>
> (ii) Occasionally, exceptions to the minimum riverine freeboard requirements...may be approved. Appropriate engineering analyses demonstrating adequate protection with a lesser freeboard must be submitted to support a request for such an exception. The material presented must evaluate the uncertainty in the estimated base flood elevation profile and include...an assessment of statistical confidence limits of the 100-year discharge; changes in stage-discharge relationships; and the sources, potential, and magnitude of debris, sediment, and ice accumulation. It must also be shown that the levee will remain structurally stable during the base flood when such additional loading considerations are imposed. Under no circumstances will freeboard of less than two feet be accepted."

FEMA does not impose a freeboard requirement when the base flood is carried without the use of a levee system. The District, however, does have additional project freeboard requirements (SCVWD, 1994) which can be more restrictive than those of FEMA, as summarized in Table 5, where "D" refers to the estimated depth of flow in feet, and "V" is flow velocity in feet per second.

Table 5
Proposed Freeboard Criteria

Situation	*FEMA (Feet)*	*District (Feet)*
Water Surface Above Natural Bank Elevation	3.0	3.5
Water Surface Above Bank within 100 feet of Structure	4.0	4.0
Water Surface Below Natural Bank Elevation	N/A	$0.2(D + V^2/2g)$
Minimum Freeboard	N/A	1.0

District guidelines suggest that freeboard at new bridges be the same as in the existing or proposed channel either upstream or downstream, whichever is greater, so that a system with a uniform level of protection is provided.

Other Design Criteria. District standards also call for the consideration of other criteria when designing new flood conveyance facilities:

1) An evaluation of bridges under debris loading, by assuming a blockage equal to three times the bridge pier diameter.

2) Freeboard should contain the discharge defined by the 80 percent confidence limit when practical to do so.

3) Channels with supercritical flow shall be designed for sequent depth plus freeboard.

4) Channels shall include freeboard for super-elevation of the design water surface at curves in addition to the requirements listed above.

5) Additional freeboard allowances may be made in areas where continued land subsidence is anticipated.

Maintenance Criteria. Regular channel maintenance is important to upholding the integrity of channel design. During preliminary and final design phases, proposed maintenance protocols on the part of the District will be iteratively evaluated for their impact on design channel roughness. For instance, unmaintained areas including grasses and emergent wetlands that are allowed to become "contaminated" with woody vegetation such as brush, willows, and even trees will be assumed to have higher roughness values in the 0.10 to 0.15 range.

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LOWER SILVER CREEK HYDRAULIC ANALYSIS

TECHNICAL MEMORANDUM: **4**

DATE: August 17, 2000

SUBJECT: ***Analysis of Bridge Hydraulics for Reaches 1-3*** (Task 5.1)

Purpose. The purpose of this task is to document the results of preliminary backwater analyses for the NRCS plan in Lower Silver Creek Reaches 1 through 3. More specifically, problems with hydraulic performance at existing bridges are pointed out so that Coyote Watershed Program staff may begin to reformulate the project plan. Based on preliminary analysis, it is clear that several bridges within Reach 3 require replacement. This memorandum is intended to provide technical backup to discussions held in an August 8, 2000 meeting with Watershed Program and District staff.

Changes to Analysis Since August 8 Meeting. A preliminary backwater profile was presented at the August 8 meeting showing potential hydraulic problems at the following bridge crossings:

1) McKee Road (primarily due to sediment accumulation)
2) Alum Rock Avenue
3) Sunset Street
4) Lausett Footbridge
5) San Antonio Street

Subsequent quality control review of the HEC-RAS model used to produce this profile reveals that the situation with existing bridges is worse than first thought due to the following model changes:

- pressure flow calculations are used in lieu of energy methods; and
- the condition without weir flow (i.e. headwalls wrapping around the bridges) is modeled.

New Hydraulic Analyses. Revised backwater profiles for Reaches 1-3 are attached to this memorandum. To examine bridge performance within the reaches, the following scenarios have been analyzed with the design one-percent discharge:

1) NRCS channel plan with existing bridges intact;

2) NRCS channel plan with existing bridge decks removed (raise bridge decks and reuse existing abutments);

3) NRCS channel plan with new clear span bridge decks at existing grade (i.e. clear spans across proposed channel while leaving road grade as-is); and

4) NRCS channel plan without regard to the bridges (i.e. the way the NRCS apparently analyzed Lower Silver Creek). This represents the condition of clear bridge spans with freeboard to the low chord.

Interstate 680 is located between Lower Silver Creek Reach 3 and Reach 4. We have measured the opening in the field, and based on preliminary calculations, this culvert should not present a hydraulic capacity problem as long as downstream deficiencies are corrected.

Interpretation of Results. These analyses (as summarized in the table below) tell us that upstream of McKee Road, the existing bridges cannot remain in their present configuration. Most of the problems appear to result from the existing bridge at Alum Rock Avenue, since it chokes the flow by operating as a sluice gate (inlet control) with high discharges (velocity is 18 fps). Pressurized flow conditions result in levee/floodwall heights of up to 18 feet above existing top of bank. The hydrostatic and dynamic forces associated with the construction of such massive headwalls to contain flood waters could destroy the bridges themselves. It is also unlikely that the public could accept such a design even if the Program felt it were feasible.

To provide adequate freeboard with minimal levee and/or floodwall heights using the NRCS channel plan, it will be necessary to provide clear spans of the new channel with raised bridge decks. Under these conditions, the design water surface is primarily carried below top of bank. Providing specific energy freeboard per SCVWD criteria requires maximum levee and/or floodwall heights of no more than about four feet. Modifications to the McKee Road bridge/culvert, other than sediment removal, have not been analyzed yet. (Once the culvert is cleaned out, proposed channel geometry and vegetation appear to control the upstream water surface.)

Table 1
Summary of Maximum Levee/Floodwall Requirements for Proposed NRCS Plan
Based on SCVWD Freeboard Criteria
(In Feet as Measured from Existing Top of Bank Grade)

Reach	*Existing Bridges*	*Raised Bridges on Exist. Abutments*	*New Clear Spans at (E) Grade*	*New Clear Spans w/ Raised Deck*
Coyote Creek to Wooster	0	N/A	N/A	N/A
Wooster to UPRR	0	N/A	N/A	N/A
UPRR to Hwy 101	0	N/A	N/A	N/A
Hwy 101 to McKee	3	N/A	N/A	N/A
McKee to Alum Rock	5	N/A	N/A	N/A
Alum Rock to Sunset	15	7	4	1
Sunset to Lausett	16	6	5	0
Lausett to San Antonio	18	5	6	0
San Antonio to I-680	16	5	7	4

Inlet Control at Alum Rock Bridge

Bridge has 25-foot wide rectangular opening with

Low Chord	95.8
Invert	- 85.3
Depth	10.5 feet

Discharge = 4,830 cfs

Q/B = 4830 / 25 = 193 cfs/ft

FHA Chart 8 (Headwater Depth for Box Culverts with Inlet Control)

HW/D = 2.1 (Index 2 for headwall)
HW = (2.1)(10.5) = 22.1 feet
EG = 22.1 + 85.3 = 107.4 (HEC-RAS Output; EG = 107.6)

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LOWER SILVER CREEK HYDRAULIC ANALYSIS

TECHNICAL MEMORANDUM: **5**

DATE: August 22, 2000

SUBJECT: ***Further Analysis of Bridge Hydraulics for Reaches 1-3*** (Task 5.1)

Purpose. This memorandum presents the results of further bridge hydraulics analyses within Lower Silver Creek Reaches 1 through 3. In particular, the effects of replacing or modifying individual bridge crossings between McKee Road and Interstate 680 are examined.

Problem Bridges. Preliminary backwater analyses have indicated the potential for hydraulic difficulties at the following bridge crossings:

1) McKee Road
2) Alum Rock Avenue
3) Sunset Street
4) Lausett Avenue Footbridge
5) San Antonio Street

In essence the difficulties are caused by pressure flow conditions that were not taken into consideration by the NRCS in its preliminary channel design. Table 1 presents hydraulic results within Reach 3 for each bridge in its existing configuration, with NRCS proposed channel improvements.

As the table shows, undersized bridge openings at every bridge cause pressurized flow conditions. The worst problem is at Alum Rock Avenue, whose bridge causes nearly eight feet of energy loss with the design discharge. Head losses at other bridges range from 1.4 feet to 3.3 feet.

As presented in Technical Memorandum No. 4, this situation does not allow a feasible implementation of the NRCS plan.

Table 1

NRCS Channel with Existing Bridges

(All Elevations are in Feet, NAVD '88)

Bridge	**Soffit Elev.**	**Energy Grade**		**Top of Bank Elev.**		**Flow Condition**
		D/S	U/S	D/S	U/S	
McKee	88.4	89.6	91.2	89	90	Pressure
Alum Rock	95.8	99.8	107.6	96	96	Pressure
Sunset	98.5	108	111.3	97.5	98	Pressure
Lausett	100.7	111.4	112.8	98	98	Pressure
San Antonio	101.9	112.9	115.3	101.5	102	Pressure

Possible Solutions. According to SCVWD freeboard criteria, existing bridges or culverts may be pressurized as long as they are structurally sound and capable of resisting the resultant lateral and uplift forces. Subject to structural analysis and possible retrofit, therefore, it is permissible to pressurize existing bridges. To minimize bridge and road replacement costs and possible impacts to the community, the backwater profile has been re-analyzed by replacing bridges one-by-one until a reasonable solution is achieved.

Calculations show that while the McKee Road Bridge is pressurized with about 1.6 feet of head loss, eliminating the pressurized condition does not drastically alter the one-percent water surface profile upstream, since channel control takes over. Therefore, if this structure can resist additional loading posed by freeboard headwalls, it is assumed to remain in place.

Alum Rock Avenue Bridge Replacement. Table 2 represents hydraulic conditions with the Alum Rock Bridge modified to span the entire proposed NRCS channel with two one-foot wide piers. The minimum soffit elevation to maintain one foot of freeboard over the energy grade line is 97.4, which is 1.6 feet higher than the existing soffit. To meet

SCVWD freeboard criteria for new bridges, the soffit elevation needs to be 98.0, which is 2.2 feet higher than existing. Large hydraulic losses are still experienced at Sunset Street, necessitating 7-foot high floodwalls between Sunset Street and San Antonio Street.

Table 2

NRCS Channel with Alum Rock Replacement

(All Elevations are in Feet, NAVD '88)

Bridge	Soffit Elev.	Energy Grade		Top of Bank Elev.		Flow Condition
		D/S	U/S	D/S	U/S	
McKee	88.4	89.6	91.2	89	90	Pressure
Alum Rock	98.0	95.9	96.4	96	96	Class A Low
Sunset	98.5	97.9	102.5	97.5	98	Inlet
Lausett	100.7	102.8	103.7	98	98	Pressure
San Antonio	101.9	103.9	105.2	101.5	102	Pressure

Sunset Street Culvert Replacement. Table 3 shows hydraulic conditions with the Alum Rock Avenue bridge replaced as described above and the Sunset Street triple box culvert replaced with a bridge that also spans the entire proposed NRCS channel using two one-foot wide piers. The minimum bridge soffit elevation to maintain one foot of freeboard over the energy grade line is 98.6, which is just 0.1 foot higher than the existing culvert soffit, so it may be possible to replace this structure with minimal changes to the roadway profile. To meet SCVWD freeboard criteria for new bridges, the soffit elevation needs to be 99.4, which is 0.9 foot higher than existing; again resulting in fairly minor potential changes to the roadway.

Once inlet control is relieved at Sunset Street, upstream hydraulic performance is greatly improved, and further bridge replacement is not warranted. The Lausett footbridge would have 2.3 feet of freeboard over the lowered energy grade line, meeting SCVWD freeboard requirements for new bridges (pending verification of the soffit elevation). At San Antonio Street, the bridge is no longer pressurized, and there appears to be sufficient clearance to remove the "floating" concrete channel lining (the bridge structure and channel lining are separate) and carry the proposed channel improvements through the bridge. This eliminates the need for channel transitions into and out of the existing bridge, improves the aesthetic appearance of the channel, and provides for fish passage.

Freeboard levees and/or floodwalls would be similar in height (or reduced in height) when compared to the NRCS plan. Upstream of San Antonio Street, the proposed channel configuration still governs the water surface profile.

Table 3

NRCS Channel with Alum Rock & Sunset Replacement

(All Elevations are in Feet, NAVD '88)

Bridge	Soffit Elev.	Energy Grade		Top of Bank Elev.		Flow Condition
		D/S	U/S	D/S	U/S	
McKee	88.4	89.6	91.2	89	90	Pressure
Alum Rock	98.0	95.9	96.4	96	96	Class A Low
Sunset	99.4	96.7	97.6	97.5	98	Class A Low
Lausett	100.7	98.4	98.4	98	98	Class A Low
San Antonio	101.9	99.4	99.8	101.5	102	Class A Low

APPENDIX D
HYDROLOGIC BACKUP

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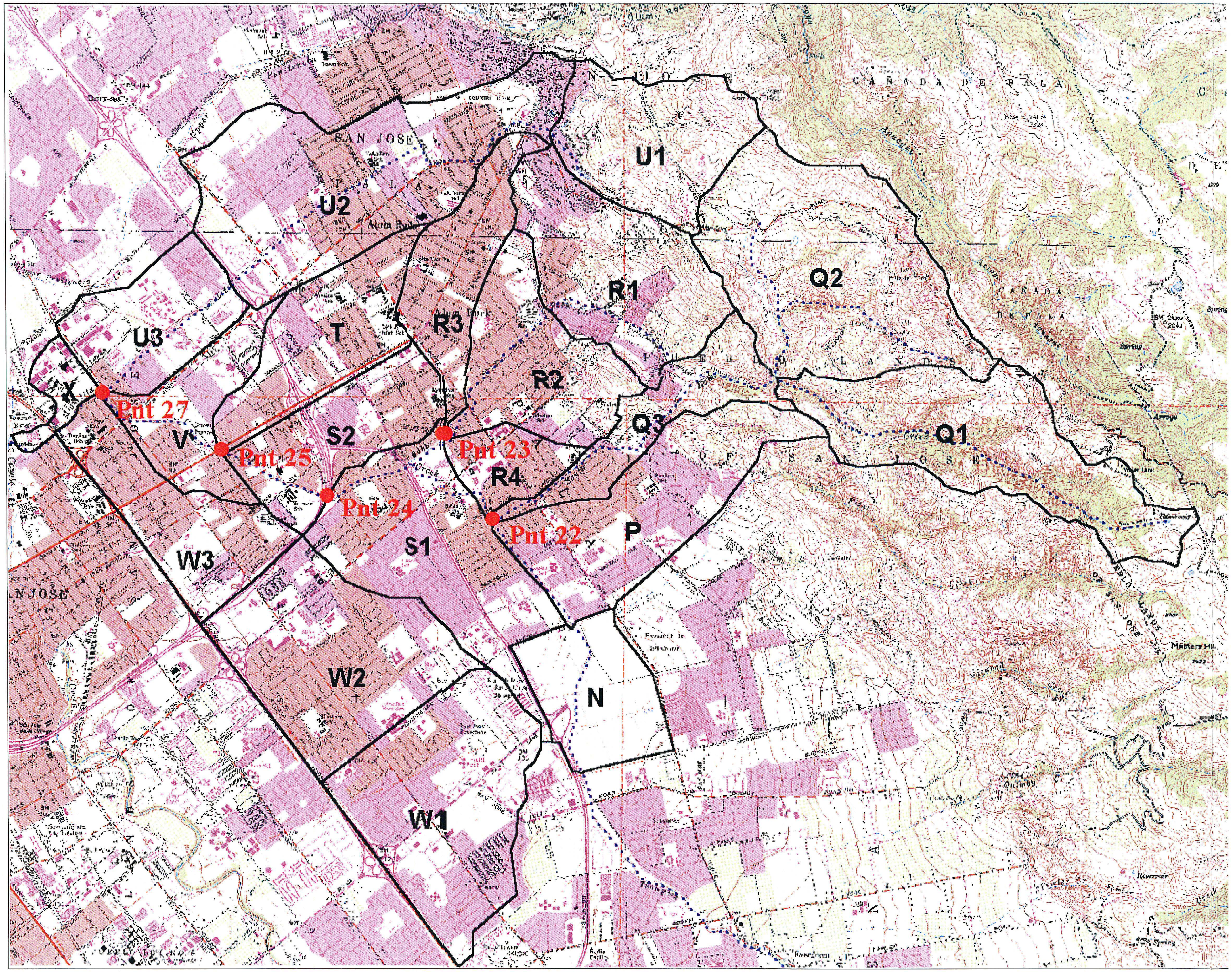

DRAINAGE BASINS

LOWER SILVER CREEK WATERSHED MODEL

D-2

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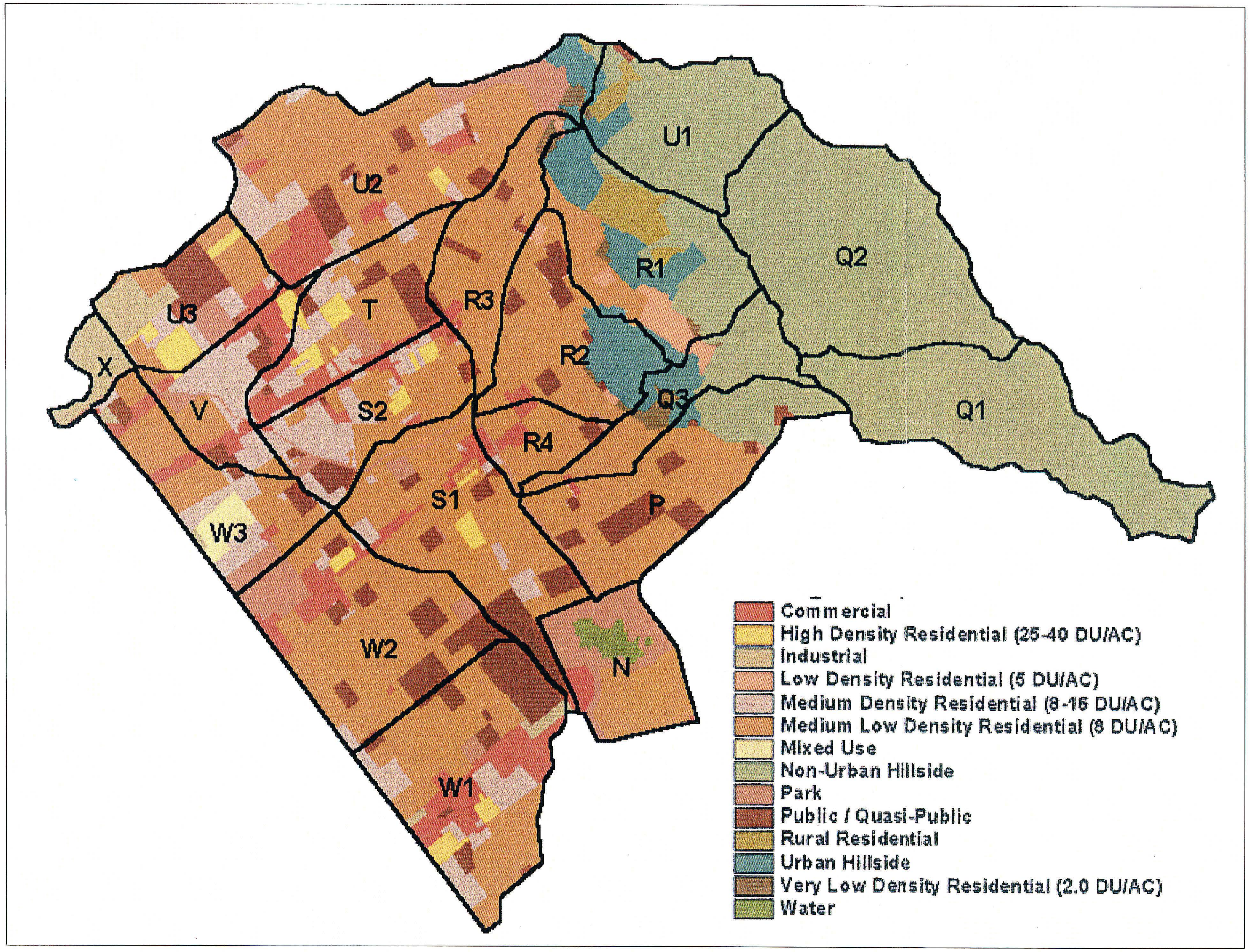
U1
U2
U3
Q1
Q2
Q3
R1
R2
R3
R4
T
X
V
S1
S2
P
N
W1
W2
W3
Commercial
High Density Residential (25-40 DU/AC)
Industrial
Low Density Residential (5 DU/AC)
Medium Density Residential (8-16 DU/AC)
Medium Low Density Residential (8 DU/AC)
Mixed Use
Non-Urban Hillside
Park
Public / Quasi-Public
Rural Residential
Urban Hillside
Very Low Density Residential (2.0 DU/AC)
Water

LAND USE

LOWER SILVER CREEK
WATERSHED MODEL

D-4

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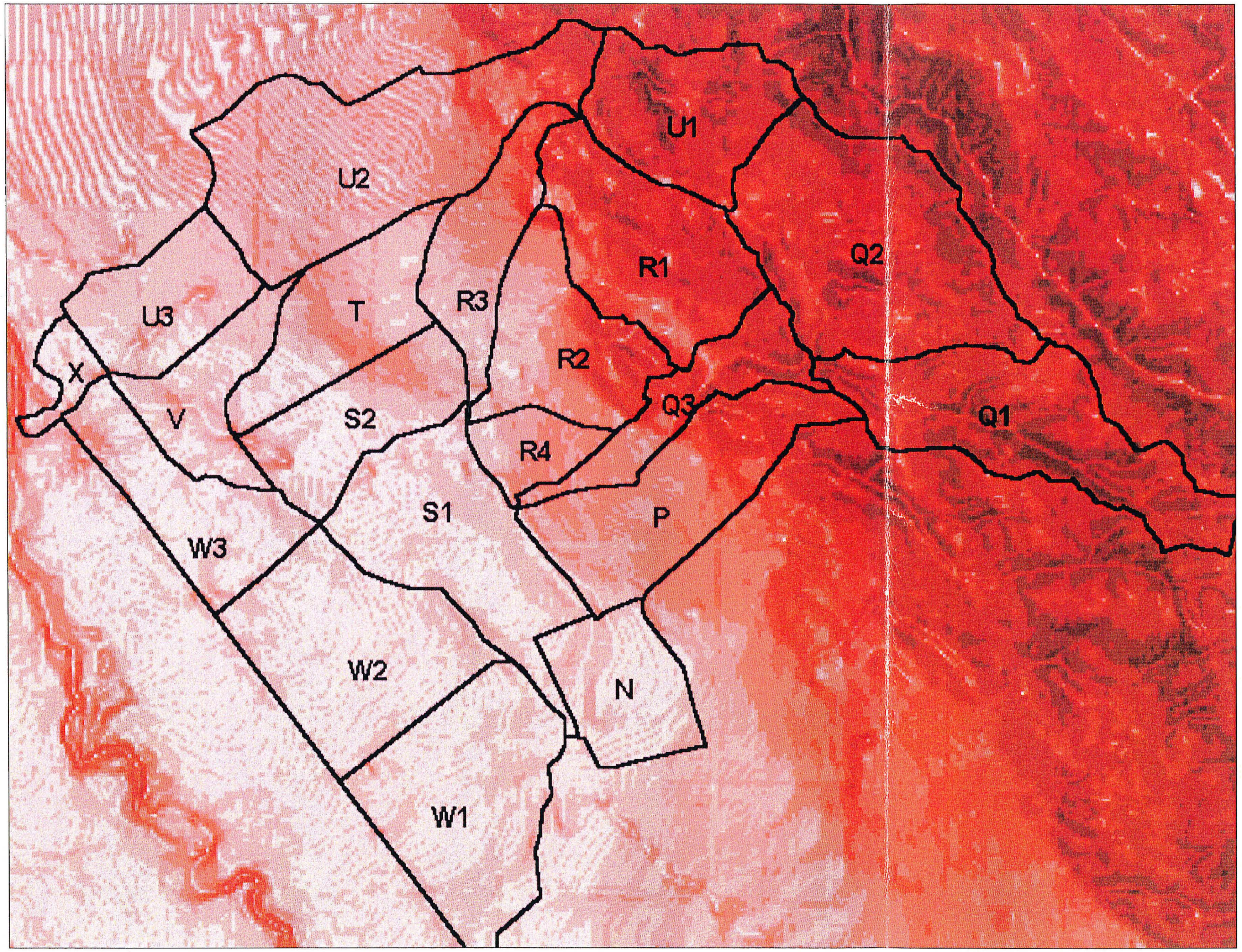
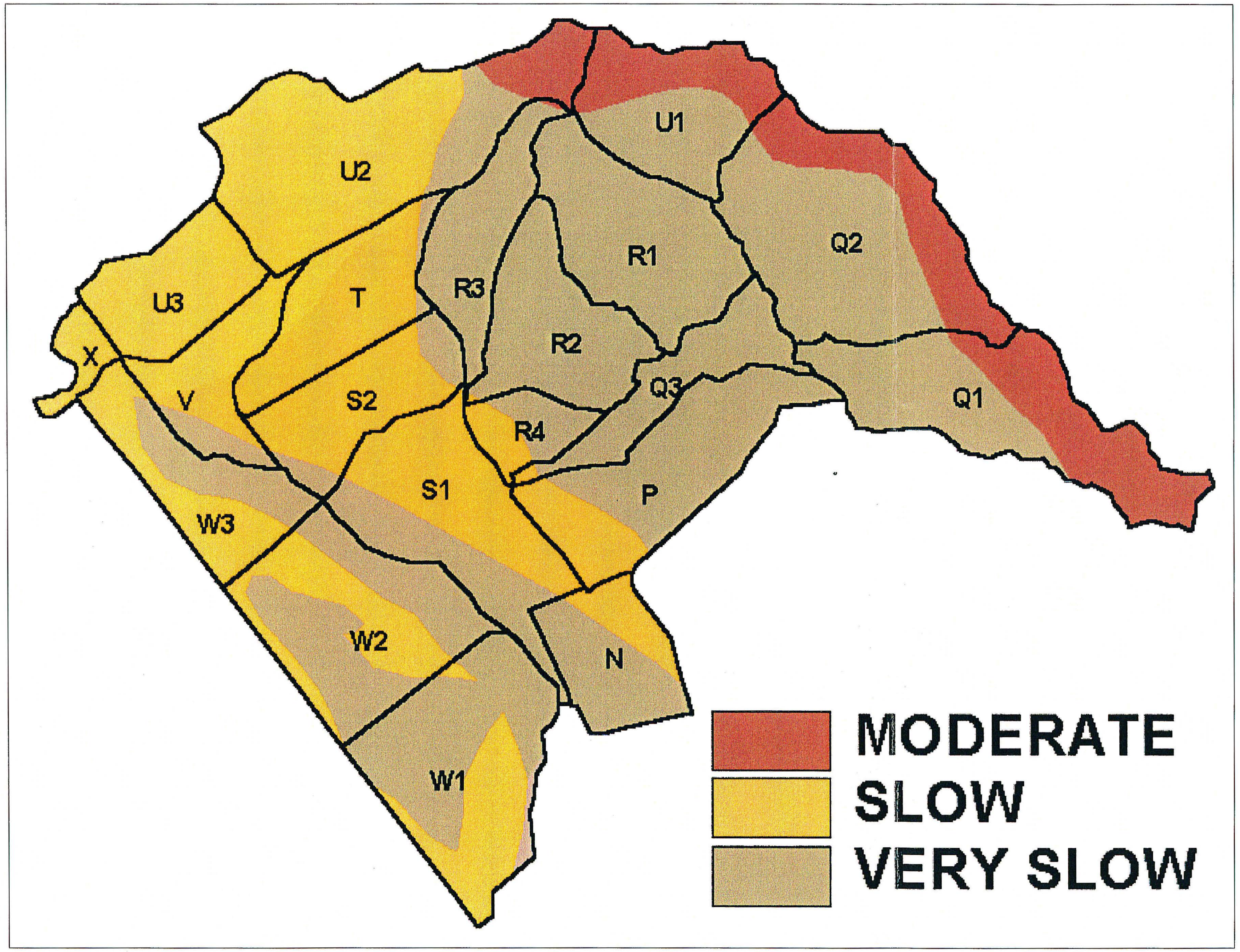


TOPOGRAPHY

LOWER SILVER CREEK
WATERSHED MODEL

D-5



SOIL GROUPS

LOWER SILVER CREEK
WATERSHED MODEL

D-3

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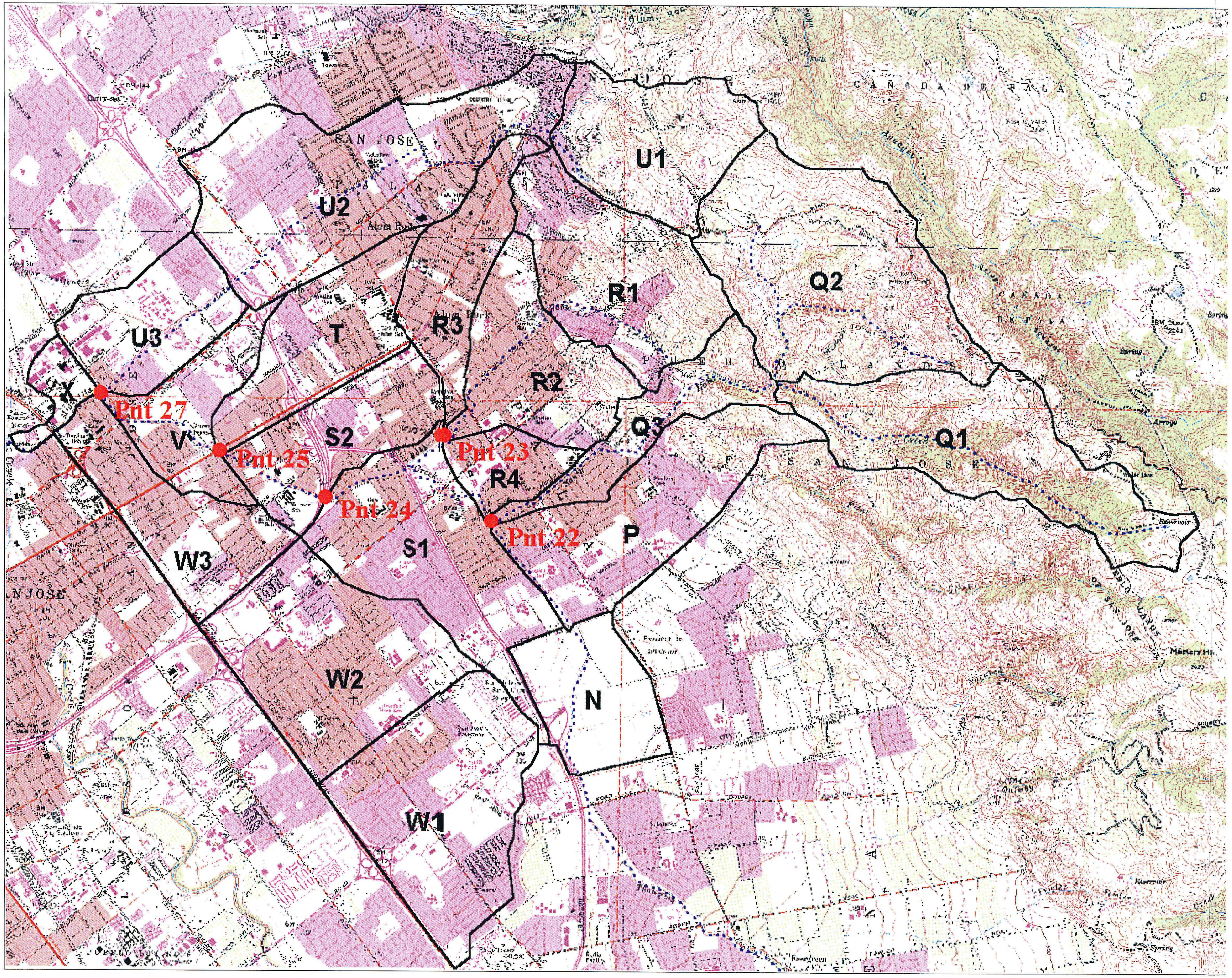

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DRAINAGE BASINS

LOWER SILVER CREEK WATERSHED MODEL

D-2

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Lower Silver Creek Watershed Model - Land Use Summary

	Rural		Mixed		Rural/Estate Residential		Low Density Residential		Medium Density Residential		High Density Residential		Commerical		Industial		Public Quasi-Public		Park		Water		Urban Hillside		Total
Basin	Area	Percent	Area	Percent	Area	Percent	Area	Percent	Area	Percent	Area	Percent	Area	Percent	Area	Percent	Area	Percent	Area	Percent	Area	Percent	Area	Percent	
SLT-N									0.25	39%			0.04	6%					0.27	43%	0.08	12%			0.63
SLT-P	0.25	22%							0.65	75%			0.01	1%			0.17	20%	0.02	2%			0.02	2%	1.11
SLT-Q1	1.37	100%																							1.37
SLT-Q2	1.79	100%																							1.79
SLT-Q3	0.25	45%					0.06	20%	0.15	50%				0%				0%		0%			0.09	28%	0.56
SLT-R1	0.35	32%			0.15	20%	0.11	15%	0.19	26%				0%				0%		0%			0.29	39%	1.09
SLT-R2							0.02	3%	0.51	60%			0.01	2%			0.10	12%					0.20	24%	0.84
SLT-R3							0.02	4%	0.53	85%			0.01	2%			0.05	7%	0.01	1%			0.01	1%	0.62
SLT-R4									0.22	74%			0.05	16%			0.02	6%	0.01	4%					0.29
SLT-S1									0.04	11%	0.03	9%	0.06	17%			0.20	52%	0.04	11%					0.38
SLT-S2									0.54	75%	0.03	5%	0.06	9%			0.06	8%	0.03	4%					0.72
SLT-T									0.46	58%	0.06	7%	0.13	17%			0.10	13%	0.03	4%					0.78
SLT-U1	0.75	87%			0.04	38%											0.01	7%					0.06	51%	0.87
SLT-U2	0.01	1%					0.02	1%	1.25	69%	0.02	1%	0.17	9%			0.12	7%	0.14	8%			0.08	4%	1.80
SLT-U3									0.24	36%	0.09	13%	0.03	5%	0.13	19%	0.13	19%	0.05	7%					0.67
SLT-V									0.33	59%	0.03	5%	0.11	20%			0.05	10%	0.03	6%					0.55
SLT-W1									0.79	58%	0.05	3%	0.24	18%	0.04	3%	0.23	17%	0.02	1%					1.36
SLT-W2									0.84	63%	0.02	1%	0.12	9%			0.22	17%	0.13	10%					1.32
SLT-W3			0.09	12%					0.49	64%			0.07	9%	0.02	2%	0.05	7%	0.05	7%					0.76
SLT-X									0.09	36%					0.14	59%			0.01	5%					0.24
TOTAL	26.9%		0.5%		1.1%		1.3%		42.5%		1.8%		6.2%		1.8%		8.4%		4.7%		0.4%		4.1%		17.8

Lower Silver Creek Watershed Model
Initial Times of Concentration

		Rural					Impervious							Street		Overland		Overland	Street		Pervious		Overland		Pervious
Basin	Area (sq mi)	Rural Area (sq mi)	Lm (ft)	n	S (ft/ft)	TCr (hr)	% Imp	Area (sq mi)	Ast (sq ft)	Wst (ft)	Lst (ft)	Li (ft)	Lcb (ft)	n	S (ft/ft)	n	S (ft/ft)	Tci (hr)	TC(c,b) (hr)		Area (sq mi)	Lp (ft)	n	S (ft/ft)	TCp (hr)
N	0.63						62%	0.391	2338159	50	46763	91.43	300	0.02	0.005	0.05	0.005	0.000	0.109	0.17	0.239	71.4	0.5	0.005	0.252
P	1.11	0.25	3800	0.07	0.068	0.36	45%	0.500	5418879	50	108378	39.24	300	0.02	0.068	0.05	0.068	0.653	0.060	0.17	0.611	78.5	0.5	0.068	0.145
Q1	1.37	1.37	14500	0.07	0.306	0.47	80%	1.096	3825514	50	76510	174.68	300	0.02	0.306	0.05	0.306	0.636	0.042	0.17	0.274	49.9	0.5	0.306	0.082
Q2	1.79	1.79	8800	0.07	0.273	0.38	80%	1.432	5000779	50	100016	174.58	300	0.02	0.273	0.05	0.273	0.467	0.043	0.17	0.358	49.9	0.5	0.273	0.085
Q3	0.56	0.25	3700	0.07	0.166	0.29	62%	0.347	2372970	50	47459	76.98	300	0.02	0.166	0.05	0.166	0.696	0.049	0.17	0.213	62.5	0.5	0.166	0.106
R1	1.09	0.35	2700	0.07	0.164	0.25	62%	0.676	4477550	50	89551	80.19	300	0.02	0.164	0.05	0.164	0.445	0.049	0.17	0.414	64.5	0.5	0.164	0.108
R2	0.84						37%	0.311	4672157	50	93443	21.36	300	0.02	0.080	0.05	0.080	0.627	0.058	0.17	0.529	78.9	0.5	0.080	0.140
R3	0.62						38%	0.236	3467811	50	69356	22.35	300	0.02	0.031	0.05	0.031	0.803	0.072	0.17	0.384	77.3	0.5	0.031	0.173
R4	0.29						34%	0.099	1600635	50	32013	17.93	300	0.02	0.016	0.05	0.016	0.627	0.084	0.17	0.191	83.3	0.5	0.016	0.209
S1	0.38						21%	0.080	1975982	50	39520	3.15	300	0.02	0.006	0.05	0.006	1.327	0.108	0.17	0.300	105.9	0.5	0.006	0.302
S2	0.72						35%	0.252	3963803	50	79276	19.31	300	0.02	0.026	0.05	0.026	0.898	0.075	0.17	0.468	82.3	0.5	0.026	0.186
T	0.78						30%	0.234	4267721	50	85354	13.21	300	0.02	0.012	0.05	0.012	0.903	0.090	0.17	0.546	89.2	0.5	0.012	0.230
U1	0.87	0.75	4000	0.07	0.286	0.26	77%	0.670	2548689	50	50974	158.19	300	0.02	0.286	0.05	0.286	0.417	0.043	0.17	0.200	54.7	0.5	0.286	0.088
U2	1.80	0.01	2200	0.07	0.054	0.29	39%	0.702	9599326	50	191987	25.97	300	0.02	0.054	0.05	0.054	0.815	0.064	0.17	1.098	79.7	0.5	0.054	0.155
U3	0.67						27%	0.181	3573080	50	71462	10.29	300	0.02	0.009	0.05	0.009	0.854	0.096	0.17	0.489	95.4	0.5	0.009	0.255
V	0.55						31%	0.171	2965485	50	59310	15.07	300	0.02	0.026	0.05	0.026	0.905	0.076	0.17	0.380	89.2	0.5	0.026	0.194
W1	1.36						28%	0.381	7547517	50	150950	10.16	300	0.02	0.005	0.05	0.005	1.120	0.112	0.17	0.979	90.4	0.5	0.005	0.289
W2	1.32						36%	0.475	6999500	50	139990	22.32	300	0.02	0.004	0.05	0.004	1.159	0.116	0.17	0.845	84.1	0.5	0.004	0.289
W3	0.76						38%	0.289	4124492	50	82490	23.80	300	0.02	0.005	0.05	0.005	1.216	0.109	0.17	0.471	79.6	0.5	0.005	0.265
X	0.24						25%	0.060	1321092	50	26422	6.65	300	0.02	0.025	0.05	0.025	0.888	0.076	0.17	0.180	95.0	0.5	0.025	0.201

Lower Silver Creek Watershed Model
Basin Travel Times

Basin	Area (sq mi)	Slope ft/ft	Length ft	"n"	Time hrs
N	0.63	0.005		0.08	0.000
P	1.11	0.057	11000	0.08	0.653
Q1	1.37	0.125	15400	0.08	0.636
Q2	1.79	0.145	8600	0.08	0.467
Q3	0.56	0.052	12000	0.08	0.696
R1	1.09	0.063	5100	0.08	0.445
R2	0.84	0.030	7300	0.08	0.627
R3	0.62	0.025	11300	0.08	0.803
R4	0.29	0.014	5000	0.08	0.627
S1	0.38	0.003	10800	0.08	1.327
S2	0.72	0.008	8100	0.08	0.898
T	0.78	0.012	10200	0.08	0.903
U1	0.87	0.188	7700	0.08	0.417
U2	1.80	0.036	14000	0.08	0.815
U3	0.67	0.007	7000	0.08	0.854
V	0.55	0.007	7600	0.08	0.905
W1	1.36	0.0032	8200	0.08	1.120
W2	1.32	0.0029	8400	0.08	1.159
W3	0.76	0.0029	9300	0.08	1.216
X	0.24	0.003	4600	0.08	0.888

Lower Silver Creek Watershed Model
Times of Concentration and Storage Coefficients

Basin	Area (sq mi)	Rural TCr (hr)	Impervious TC_{imp} (hr)	Pervious TC_{perv} (hr)	Impervious R/(Tc+R)	Pervious R/(Tc+R)	Rural R (hr)	Impervious R (hr)	Pervious R (hr)
N									
P	1.11	0.65	0.823	0.969	0.4	0.75	1.96	0.55	2.91
Q1	1.37	0.64	0.806	0.889	0.4	0.75	1.91	0.54	2.67
Q2	1.79	0.47	0.637	0.722	0.4	0.75	1.40	0.42	2.17
Q3	0.56	0.70	0.866	0.971	0.4	0.75	2.09	0.58	2.91
R1	1.09	0.44	0.615	0.722	0.4	0.75	1.33	0.41	2.17
R2	0.84		0.797	0.937	0.4	0.75		0.53	2.81
R3	0.62		0.973	1.146	0.4	0.75		0.65	3.44
R4	0.29		0.797	1.006	0.4	0.75		0.53	3.02
S1	0.38		1.497	1.798	0.4	0.75		1.00	5.40
S2	0.72		1.068	1.253	0.4	0.75		0.71	3.76
T	0.78		1.073	1.304	0.4	0.75		0.72	3.91
U1	0.87	0.42	0.587	0.675	0.4	0.75	1.25	0.39	2.02
U2	1.80	0.82	0.985	1.140	0.4	0.75	2.45	0.66	3.42
U3	0.67		1.024	1.278	0.4	0.75		0.68	3.83
V	0.55		1.075	1.269	0.4	0.75		0.72	3.81
W1	1.36		1.290	1.579	0.4	0.75		0.86	4.74
W2	1.32		1.329	1.618	0.4	0.75		0.89	4.85
W3	0.76		1.386	1.651	0.4	0.75		0.92	4.95
X	0.24		1.058	1.260	0.4	0.75		0.71	3.78

SILVER CREEK
HYDROLOGIC SOIL GROUPS

Basin	Area	RURAL								URBAN						AMC II						
		B	C	D	B	C	D	Rural	Ia	B		C		D		B	C	D	Pervioius	Ia	Impervioius	Ia
		%	%	%	CN	CN	CN	CN	(in)	area	%	area	%	area	%	CN	CN	CN	CN	(in)	CN	(in)
SLT-N	0.63											0.19	30%	0.44	70%		23.4	59.1	83	0.42	98	0.04
SLT-P	1.11			100%			86	86	0.63			0.29	26%	0.82	74%		20.6	62.1	83	0.42	98	0.04
SLT-Q1	1.37		49%	51%		37	44	81	0.54			0.68	49%	0.70	51%		38.9	42.7	82	0.45	98	0.04
SLT-Q2	1.79		33%	67%		25	58	83	0.57			0.60	33%	1.19	67%		26.4	55.9	82	0.43	98	0.04
SLT-Q3	0.56			100%			86	86	0.63			0.02	3%	0.54	97%		2.2	81.7	84	0.38	98	0.04
SLT-R1	1.09			100%			86	86	0.63					1.09	100%			84.0	84	0.38	98	0.04
SLT-R2	0.84													0.84	100%			84.0	84	0.38	98	0.04
SLT-R3	0.62											0.01	1%	0.62	99%		0.9	83.0	84	0.38	98	0.04
SLT-R4	0.29											0.12	40%	0.18	60%		31.4	50.6	82	0.44	98	0.04
SLT-S1	1.22											0.75	61%	0.47	39%		48.3	32.6	81	0.47	98	0.04
SLT-S2	0.72											0.57	79%	0.15	21%		62.5	17.6	80	0.50	98	0.04
SLT-T	0.78									0.14	18%	0.59	76%	0.05	6%	12.5	60.0	5.0	77	0.58	98	0.04
SLT-U1	0.87		42%	58%		32	50	82	0.55			0.41	47%	0.46	53%	0.0	37.2	44.5	82	0.45	98	0.04
SLT-U2	1.80		100%			76		76	0.44	1.33	74%	0.23	13%	0.24	14%	50.9	10.0	11.4	72	0.73	98	0.04
SLT-U3	0.67									0.67	100%					69.0			69	0.83	98	0.04
SLT-V	0.55									0.32	58%	0.11	21%	0.11	21%	40.2	16.4	17.6	74	0.67	98	0.04
SLT-W1	1.36									0.48	35%	0.04	3%	0.84	62%	24.3	2.3	51.9	79	0.54	98	0.04
SLT-W2	1.32									0.50	38%			0.82	62%	26.3		51.9	78	0.55	98	0.04
SLT-W3	0.76									0.46	60%			0.31	40%	41.2		33.8	75	0.65	98	0.04
SLT-X	0.16									0.16	100%					69.0			69	0.83	98	0.04
TTL	18.53									4.06	22%	4.59	25%	9.88	53%				79	0.52	98	0.04

LOWER SILVER CREEK WATERSHED MODEL
CURVE NUMBER ADJUSTMENT FOR ANTECEDENT MOISTURE

CN (AMCII)	CN (AMCI)	CN (AMCIII)	CN (AMC2.5)	CN (AMC2.75)
65	45	83	74	79
66	46	84	75	79
67	47	85	76	80
68	49	85	77	81
69	50	86	78	82
70	51	87	79	83
71	52	88	79	84
72	53	89	80	84
73	55	89	81	85
74	56	90	82	86
75	57	91	83	87
76	58	92	84	88
77	59	92	85	88
78	61	93	85	89
79	62	93	86	90
80	63	94	87	91
81	64	95	88	91
82	66	95	89	92
83	67	96	89	93
84	69	96	90	93
85	70	97	91	94
86	72	97	92	94
87	73	97	92	95
88	75	98	93	95
89	76	98	93	96
90	78	98	94	96
91	80	98	95	96
92	82	98	95	97
93	83	99	96	97
94	85	99	96	98
95	87	99	97	98
96	90	99	98	98
97	92	99	98	99
98	95	100	99	99
99	97	100	99	100
100	100	100	100	100

Generalized Unitized Urban Storage-Discharge Relationships

A>400ac (0.625 sq mi) w/o levees on hillsides [A]										
SV	0	2.5	7.5	10	12.5	20	30	80	130	180
SQ	0	28	70	80	85	125	155	360	560	755
A>400ac w/o levees [B]										
SV	0	2.5	7.5	10	12.5	20	30	80	130	180
SQ	0	28	70	80	85	125	155	155	155	155
A>400ac w/ levees [C]										
SV	0	2.5	7.5	10	12.5	20	30	80	130	180
SQ	0	28	70	80	85	90	92	92	92	92
A<400ac w/o levees on hillsides [D]										
SV	0	2.5	7.5	10	12.5	20	30	80	130	180
SQ	0	46	150	180	205	240	280	465	685	850
A<400ac w/o levees [E]										
SV	0	2.5	7.5	10	12.5	20	30	80	130	180
SQ	0	46	150	180	205	240	280	280	280	280
A<400ac w/ levees [F]										
SV	0	2.5	7.5	10	12.5	20	30	80	130	180
SQ	0	46	150	180	205	215	220	220	220	220

Storm Drain Routing In Lower Silver Creek Watershed

Basin	Tributary	Urban (sq. mi)	Condition											
N	N	0.63	Not Used	SV										
				SQ										
P	P	0.86	C	SV	0.0	2.2	6.5	8.6	10.8	17.2	25.8	68.8	111.8	154.8
				SQ	0.0	24.1	60.2	68.8	73.1	77.4	79.1	79.1	79.1	79.1
Q1	Q1	1.37	Rural	SV										
				SQ										
Q2	Q2	1.79	Rural	SV										
				SQ										
Q3	Q3	0.63	B	SV	0.0	1.6	4.7	6.3	7.9	12.6	18.9	50.4	81.9	113.4
				SQ	0.0	17.6	44.1	50.4	53.6	78.8	97.7	97.7	97.7	97.7
	R1	0.74	A	SV	0.0	1.9	5.6	7.4	9.3	14.8	22.2	59.2	96.2	133.2
				SQ	0.0	20.7	51.8	59.2	62.9	92.5	114.7	266.4	414.4	558.7
	R2	0.84	B	SV	0.0	2.1	6.3	8.4	10.5	16.8	25.2	67.2	109.2	151.2
				SQ	0.0	23.5	58.8	67.2	71.4	105.0	130.2	130.2	130.2	130.2
	R3	0.62	E	SV	0.0	1.6	4.7	6.2	7.8	12.4	18.6	49.6	80.6	111.6
				SQ	0.0	28.5	93.0	111.6	127.1	148.8	173.6	173.6	173.6	173.6
	R4	0.29	F	SV	0.0	0.7	2.2	2.9	3.6	5.8	8.7	23.2	37.7	52.2
				SQ	0.0	13.3	43.5	52.2	59.5	62.4	63.8	63.8	63.8	63.8
	S1	0.38	F	SV	0.0	1.0	2.9	3.8	4.8	7.6	11.4	30.4	49.4	68.4
				SQ	0.0	17.5	57.0	68.4	77.9	81.7	83.6	83.6	83.6	83.6
	S2	0.72	C	SV	0.0	1.8	5.4	7.2	9.0	14.4	21.6	57.6	93.6	129.6
				SQ	0.0	20.2	50.4	57.6	61.2	64.8	66.2	66.2	66.2	66.2
	T	0.78	C	SV	0.0	2.0	5.9	7.8	9.8	15.6	23.4	62.4	101.4	140.4
				SQ	0.0	21.8	54.6	62.4	66.3	70.2	71.8	71.8	71.8	71.8
	U1	0.12	D	SV	0.0	0.3	0.9	1.2	1.5	2.4	3.6	9.6	15.6	21.6
				SQ	0.0	5.5	18.0	21.6	24.6	28.8	33.6	55.8	82.2	102.0
	U2	1.8	B	SV	0.0	4.5	13.5	18.0	22.5	36.0	54.0	144.0	234.0	324.0
				SQ	0.0	50.4	126.0	144.0	153.0	225.0	279.0	279.0	279.0	279.0
	U3	0.67	B	SV	0.0	1.7	5.0	6.7	8.4	13.4	20.1	53.6	87.1	120.6
				SQ	0.0	18.8	46.9	53.6	57.0	83.8	103.9	103.9	103.9	103.9
	V	0.55	F	SV	0.0	1.4	4.1	5.5	6.9	11.0	16.5	44.0	71.5	99.0
				SQ	0.0	25.3	82.5	99.0	112.8	118.3	121.0	121.0	121.0	121.0
	W1	1.36	B	SV	0.0	3.4	10.2	13.6	17.0	27.2	40.8	108.8	176.8	244.8
				SQ	0.0	38.1	95.2	108.8	115.6	170.0	210.8	210.8	210.8	210.8
	W2	1.32	B	SV	0.0	3.3	9.9	13.2	16.5	26.4	39.6	105.6	171.6	237.6
				SQ	0.0	37.0	92.4	105.6	112.2	165.0	204.6	204.6	204.6	204.6
	W1 - W3	3.44	C	SV	0.0	8.6	25.8	34.4	43.0	68.8	103.2	275.2	447.2	619.2
				SQ	0.0	96.3	240.8	275.2	292.4	309.6	316.5	316.5	316.5	316.5
	X	0.24	F	SV	0.0	0.6	1.8	2.4	3.0	4.8	7.2	19.2	31.2	43.2
				SQ	0.0	11.0	36.0	43.2	49.2	51.6	52.8	52.8	52.8	52.8

Lower Silver Creek Watershed Model
INTRA-BASIN ROUTING

Basin	Nodes	Side Slope	Bottom Width	Length	Slope	HEC-2 "n"	Shape	Material
N		2	95	8000	0.001	0.04	TRAP	NATURAL
P		2.2	20	4300	0.001	0.04	TRAP	NATURAL
Q3		0.8	3	9500	0.049	0.04	TRAP	NATURAL
Q3		1	4	2500	0.018	0.04	TRAP	NATURAL
R2				500	0.009	0.013	PIPE	54" RCP
R2				1500	0.009	0.013	PIPE	60" RCP
R2		1	3	1000	0.009	0.04	TRAP	
R2				1200	0.009	0.013	PIPE	72" RCP
R2				1000	0.009	0.013	PIPE	84" RCP
R2		1	7	1500	0.009	0.04	TRAP	
S1		2.3	10	1300	0.004	0.04	TRAP	
S1		1	3	1200	0.004	0.04	TRAP	
S1		1.5	6	1500	0.004	0.04	TRAP	
S2		1.5	9	2200	0.003	0.04	TRAP	
S2		0.75	19.5	1400	0.003	0.04	TRAP	
U2		0.5	1	3000	0.042	0.04	TRAP	NATURAL
U2				1500	0.044	0.013	BOX	3, X 3.5' RCB
U2				750	0.012	0.013	PIPE	60" RCP
U2				7000	0.012	0.013	PIPE	66" RCP
U2				1000	0.012	0.013	PIPE	72" RCP
U3				1600	0.008	0.013	PIPE	72" RCP
U3		1	7	500	0.008	0.04	TRAP	NATURAL
U3				3000	0.008	0.013	PIPE	78" RCP
V		1	20	800	0.006	0.04	TRAP	
V		1	19.5	4200	0.006	0.04	TRAP	
X				2000	0.001	0.013	PIPE	78" RCP
X		2	22	2000	0.001	0.04	TRAP	NATURAL

STORAGE AVAILABLE AT LAKE CUNNINGHAM PARK

	Elevation (NGVD)	Elevation (NAVD)	Area (ft^2)	Volume (ft^3)	Volume (ac-ft)
Meadow	118.6	121.5	-	0	0
	119.1	122	202,324	50,581	1
	120.1	123	608,340	405,332	10
	121.1	124	1,017,080	812,710	29
	122.1	125	1,329,119	1,173,100	56
	123.1	126	1,459,976	1,394,548	88
Lake	120.3	123.2	2,163,806	0	0
	121.1	124	2,238,276	1,760,833	40
	122.1	125	2,365,805	2,302,041	93
	123.1	126	2,455,650	2,410,728	149
Park	123.1	126	3,915,626	-	237
	124.1	127	4,104,485	4,010,056	329
	125.1	128	4,279,220	4,191,853	425
	126.1	129	5,499,668	4,889,444	537
	127.1	130	5,825,701	5,662,685	667
	128.1	131	6,086,601	5,956,151	804
	129.1	132	6,292,605	6,189,603	946
	130.1	133	6,599,889	6,446,247	1094

Creek Weir Length =	900	feet	**Lake Weir Length**	1000	feet	**Meadow**	6	Siphons	**Lake**	3	Siphons
Weir Elevation =	129.5	NAVD	Weir Elevation =	126	NAVD	**Drain**	36	inch diameter	**Drain**	36	inch diameter
Coef. Of Discharge =	2.6		Coef. Of Discharge =	2.6			0.8	Discharge Coeff		0.8	Discharge Coeff

HEC-1 Ord	Time After End of DR	Time	Combined Inflow	Flow thru Control	WSEL at Weir	Spill to Meadow	Volume to Meadow	Volume in Meadow	WSEL in Meadow	h_d/H_e	C_s	Spill to Lake	Volume to Lake	Volume in Lake	WSEL in Lake
	(hours)	(hours)	(cfs)	(cfs)	(NAVD)	(cfs)	(ac-ft)	(ac-ft)	(NAVD)			(cfs)	(ac-ft)	(ac-ft)	(NAVD)
1		0	0	0	121.20				121.5						123.2
2		0.17	0	0	121.20				121.5						123.2
3		0.33	0	0	121.20				121.5						123.2
4		0.50	1	1	121.21				121.5						123.2
5		0.67	1	1	121.21				121.5						123.2
6		0.83	2	2	121.22				121.5						123.2
7		1.00	5	5	121.29				121.5						123.2
8		1.17	10	10	121.62				121.5						123.2
9		1.33	19	19	121.73				121.5						123.2
10		1.50	32	32	121.94				121.5						123.2
11		1.67	50	50	122.04				121.5						123.2
12		1.83	74	74	122.18				121.5						123.2
13		2.00	101	101	122.34				121.5						123.2
14		2.17	130	130	122.51				121.5						123.2
15		2.33	158	158	122.67				121.5						123.2
16		2.50	186	186	122.83				121.5						123.2
17		2.67	211	211	122.97				121.5						123.2
18		2.83	234	234	123.11				121.5						123.2
19		3.00	254	254	123.22				121.5						123.2
20		3.17	273	273	123.33				121.5						123.2
21		3.33	291	291	123.39				121.5						123.2
22		3.50	312	312	123.46				121.5						123.2
23		3.67	335	335	123.53				121.5						123.2
24		3.83	361	361	123.62				121.5						123.2
25		4.00	392	392	123.72				121.5						123.2
26		4.17	427	427	123.83				121.5						123.2
27		4.33	466	466	123.96				121.5						123.2
28		4.50	511	511	124.11				121.5						123.2
29		4.67	562	562	124.27				121.5						123.2
30		4.83	620	620	124.46				121.5						123.2
31		5.00	684	684	124.63				121.5						123.2
32		5.17	754	754	124.81				121.5						123.2
33		5.33	825	825	125.00				121.5						123.2
34		5.50	893	893	125.18				121.5						123.2
35		5.67	954	954	125.34				121.5						123.2
36		5.83	1007	1007	125.48				121.5						123.2
37		6.00	1055	1055	125.60				121.5						123.2
38		6.17	1097	1097	125.72				121.5						123.2
39		6.33	1136	1136	125.82				121.5						123.2
40		6.50	1171	1171	125.91				121.5						123.2
41		6.67	1201	1201	125.98				121.5						123.2
42		6.83	1228	1228	126.05				121.5						123.2
43		7.00	1252	1252	126.11				121.5						123.2
44		7.17	1273	1273	126.16				121.5						123.2
45		7.33	1297	1297	126.22				121.5						123.2
46		7.50	1324	1324	126.29				121.5						123.2
47		7.67	1355	1355	126.37				121.5						123.2
48		7.83	1390	1390	126.45				121.5						123.2
49		8.00	1427	1427	126.54				121.5						123.2
50		8.17	1466	1466	126.64				121.5						123.2
51		8.33	1505	1505	126.73				121.5						123.2
52		8.50	1544	1544	126.83				121.5						123.2
53		8.67	1582	1582	126.92				121.5						123.2
54		8.83	1617	1617	127.00				121.5						123.2
55		9.00	1651	1651	127.08				121.5						123.2
56		9.17	1681	1681	127.15				121.5						123.2
57		9.33	1705	1705	127.21				121.5						123.2
58		9.50	1723	1723	127.25				121.5						123.2
59		9.67	1738	1738	127.29				121.5						123.2
60		9.83	1751	1751	127.32				121.5						123.2
61		10.00	1762	1762	127.35				121.5						123.2
62		10.17	1773	1773	127.37				121.5						123.2
63		10.33	1783	1783	127.40				121.5						123.2
64		10.50	1793	1793	127.42				121.5						123.2
65		10.67	1803	1803	127.45				121.5						123.2
66		10.83	1813	1813	127.47				121.5						123.2
67		11.00	1821	1821	127.49				121.5						123.2
68		11.17	1826	1826	127.51				121.5						123.2
69		11.33	1830	1830	127.52				121.5						123.2
70		11.50	1836	1836	127.53				121.5						123.2
71		11.67	1844	1844	127.55				121.5						123.2
72		11.83	1856	1856	127.58				121.5						123.2
73		12.00	1871	1871	127.61				121.5						123.2
74		12.17	1888	1888	127.65				121.5						123.2
75		12.33	1907	1907	127.70				121.5						123.2
76		12.50	1925	1925	127.74				121.5						123.2
77		12.67	1940	1940	127.78				121.5						123.2
78		12.83	1953	1953	127.81				121.5						123.2
79		13.00	1969	1969	127.85				121.5						123.2
80		13.17	1992	1992	127.90				121.5						123.2
81		13.33	2027	2027	127.98				121.5						123.2
82		13.50	2075	2075	128.10				121.5						123.2

Creek Weir Length =	900	feet	**Lake Weir Length**	1000	feet	**Meadow**	6	Siphons	**Lake**	3	Siphons
Weir Elevation =	129.5	NAVD	Weir Elevation =	126	NAVD	**Drain**	36	inch diameter	**Drain**	36	inch diameter
Coef. Of Discharge =	2.6		Coef. Of Discharge =	2.6			0.8	Discharge Coeff		0.8	Discharge Coeff

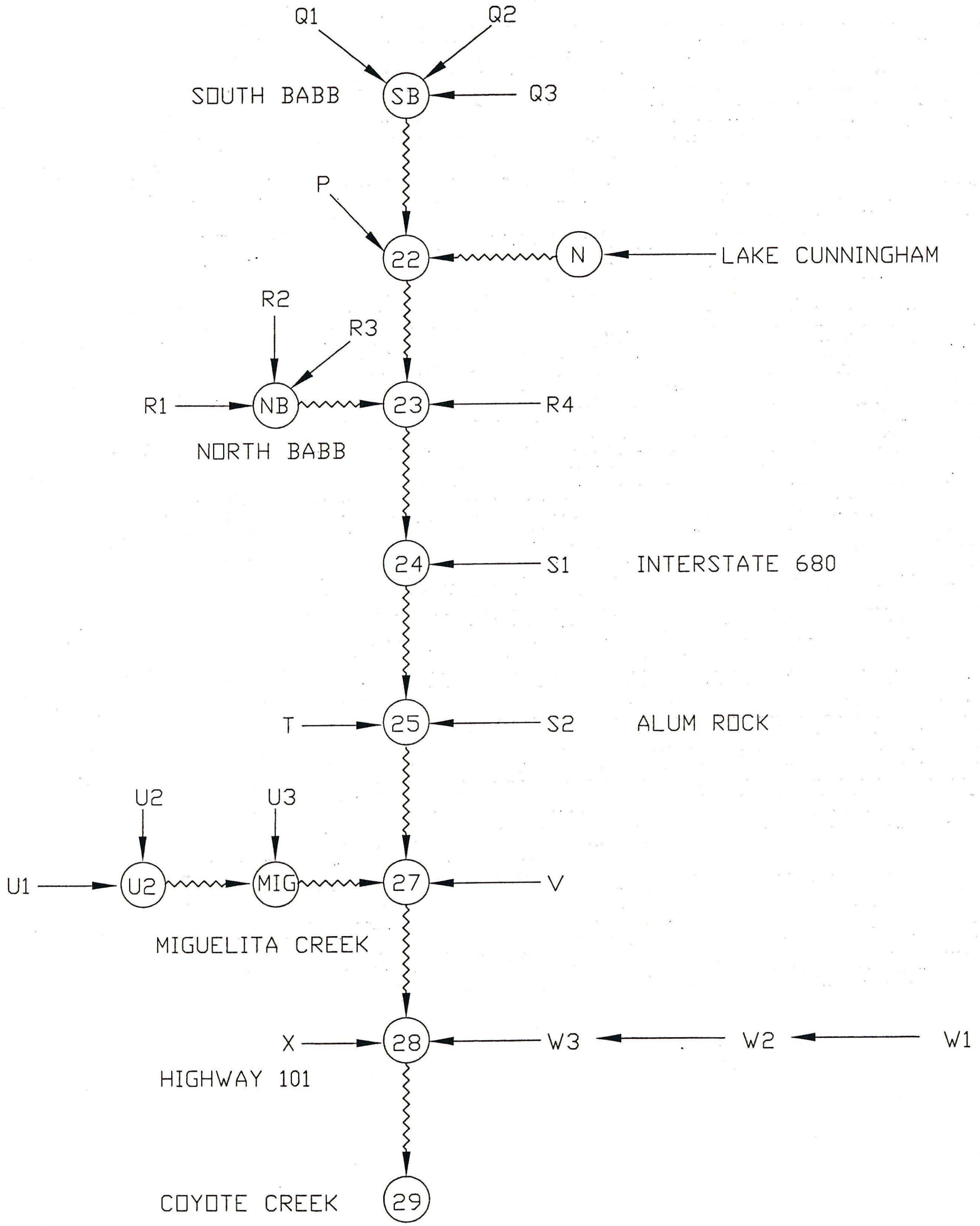
HEC-1 Ord	Time After End of DR	Time	Combined Inflow	Flow thru Control	WSEL at Weir	Spill to Meadow	Volume to Meadow	Volume in Meadow	WSEL in Meadow	h_d/H_e	C_s	Spill to Lake	Volume to Lake	Volume in Lake	WSEL in Lake
	(hours)	(hours)	(cfs)	(cfs)	(NAVD)	(cfs)	(ac-ft)	(ac-ft)	(NAVD)			(cfs)	(ac-ft)	(ac-ft)	(NAVD)
83		13.67	2135	2135	128.24				121.5						123.2
84		13.83	2209	2209	128.42				121.5						123.2
85		14.00	2299	2299	128.64				121.5						123.2
86		14.17	2399	2399	128.88				121.5						123.2
87		14.33	2494	2494	129.12				121.5						123.2
88		14.50	2567	2567	129.30				121.5						123.2
89		14.67	2605	2605	129.41	0	0	0	121.50						123.2
90		14.83	2615	2590	129.55	25	0	0	121.65						123.2
91		15.00	2616	2590	129.55	26	0	1	121.81						123.2
92		15.17	2627	2590	129.56	37	1	1	122.01						123.2
93		15.33	2660	2610	129.58	50	1	2	122.08						123.2
94		15.50	2719	2620	129.62	99	1	3	122.23						123.2
95		15.67	2799	2630	129.67	169	2	6	122.48						123.2
96		15.83	2896	2650	129.72	246	3	9	122.84						123.2
97		16.00	3005	2680	129.77	325	4	13	123.16						123.2
98		16.17	3120	2710	129.81	410	6	19	123.46						123.2
99		16.33	3233	2740	129.85	493	7	26	123.83						123.2
100		16.50	3329	2745	129.90	584	8	34	124.18						123.2
101		16.67	3402	2752	129.93	650	9	43	124.51						123.2
102		16.83	3454	2757	129.95	697	10	53	124.87						123.2
103		17.00	3501	2759	129.97	742	10	63	125.21						123.2
104		17.17	3564	2760	129.99	804	11	74	125.57						123.2
105		17.33	3664	2759	130.03	904	12	86	125.97					0	123.20
106		17.50	3812	2741	130.09	1071	15	96	126.26	—	2.6	337	5	5	123.29
107		17.67	4013	2732	130.17	1281	18	103	126.45	—	2.6	779	11	15	123.50
108		17.83	4254	2721	130.25	1533	21	107	126.58	—	2.6	1150	16	31	123.82
109		18.00	4514	2714	130.34	1800	25	110	126.68	—	2.6	1461	20	51	124.21
110		18.17	4761	2690	130.42	2071	29	113	126.76	—	2.6	1714	24	75	124.65
111		18.33	4952	2685	130.48	2267	31	115	126.82	—	2.6	1918	26	101	125.15
112		18.50	5053	2698	130.50	2355	32	116	126.86	—	2.6	2066	28	130	125.66
113		18.67	5059	2720	130.50	2339	32	118	126.89	0.78	2.6	2184	30	160	126.20
114		18.83	4988	2745	130.47	2243	31	119	126.95	0.25	2.3	2144	30	189	126.71
115		19.00	4871	2772	130.43	2099	29	127	127.17	0.07	1.2	1553	21	211	127.08
116		19.17	4735	2786	130.39	1949	27	137	127.44	0.05	0.7	1262	17	228	127.37
117		19.33	4591	2796	130.34	1795	25	146	127.67	0.02	0.5	1170	16	244	127.64
118		19.50	4447	2807	130.29	1640	23	146	127.68	0.00	0.1	175	2	247	127.68
119		19.67	4312	2807	130.25	1505	21	414	127.90						127.90
120		19.83	4188	2803	130.21	1385	19	433	128.09						128.09
121		20.00	4074	2796	130.17	1279	18	451	128.24						128.24
122		20.17	3967	2791	130.13	1176	16	467	128.39						128.39
123		20.33	3863	2786	130.10	1077	15	482	128.52						128.52
124		20.50	3760	2780	130.06	980	13	495	128.64						128.64
125		20.67	3656	2771	130.02	885	12	507	128.75						128.75
126		20.83	3552	2766	129.98	786	11	518	128.87						128.87
127		21.00	3454	2759	129.95	695	10	528	128.94						128.94
128		21.17	3362	2753	129.91	609	8	536	129.00						129.00
129		21.33	3275	2745	129.87	530	7	543	129.06						129.06
130		21.50	3192	2730	129.84	462	6	550	129.11						129.11
131		21.67	3117	2710	129.81	407	6	555	129.15						129.15
132		21.83	3050	2697	129.78	353	5	560	129.19						129.19
133		22.00	2997	2685	129.76	312	4	565	129.22						129.22
134		22.17	2957	2675	129.74	282	4	569	129.25						129.25
135		22.33	2928	2670	129.73	258	4	572	129.27						129.27
136		22.50	2903	2665	129.72	238	3	575	129.30						129.30
137		22.67	2878	2658	129.71	220	3	578	129.32						129.32
138		22.83	2852	2652	129.69	200	3	581	129.34						129.34
139		23.00	2824	2645	129.68	179	2	584	129.36						129.36
140		23.17	2796	2638	129.67	158	2	586	129.38						129.38
141		23.33	2765	2632	129.65	133	2	588	129.39						129.39
142		23.50	2732	2626	129.63	110	2	589	129.40						129.40
143		23.67	2698	2612	129.61	91	1	590	129.41						129.41
144		23.83	2665	2605	129.60	71	1	591	129.42						129.42
145		24.00	2636	2636	129.57	46	1	592	129.42						129.42
146		24.17	2607	2607	129.55	27	0	592	129.43						129.43
147		24.33	2564	2557	129.52	7	0	592	129.43						129.43
148		24.50	2493	2578	129.33	-85	-1	591	129.42						129.42
149		24.67	2384	2514	129.19	-130	-2	589	129.41						129.41
150		24.83	2244	2417	129.00	-173	-2	587	129.39						129.39
151		25.00	2087	2314	128.69	-227	-3	584	129.36						129.36
152		25.17	1928	2190	128.44	-262	-4	580	129.34						129.34
153		25.33	1778	2071	128.18	-293	-4	576	129.31						129.31
154		25.50	1644	1971	127.86	-327	-5	572	129.27						129.27
155		25.67	1524	1873	127.63	-349	-5	567	129.24						129.24
156		25.83	1417	1784	127.42	-367	-5	562	129.20						129.20
157		26.00	1317	1702	127.20	-385	-5	557	129.16						129.16
158		26.17	1222	1621	127.01	-399	-5	551	129.12						129.12
159		26.33	1132	1544	126.83	-412	-6	545	129.07						129.07
160		26.50	1044	1469	126.64	-425	-6	540	129.03						129.03
161		26.67	959	1395	126.47	-436	-6	534	128.98						128.98
162		26.83	881	1327	126.30	-446	-6	527	128.93						128.93
163		27.00	810	1264	126.15	-454	-6	521	128.87						128.87
164		27.17	746	1207	126.00	-461	-6	515	128.81						128.81

Creek Weir Length =		900	feet	**Lake Weir Length**		1000	feet	**Meadow**	6	Siphons			**Lake**	3	Siphons
Weir Elevation =		129.5	NAVD	Weir Elevation =		126	NAVD	**Drain**	36	inch diameter			**Drain**	36	inch diameter
Coef. Of Discharge =		2.6		Coef. Of Discharge =		2.6			0.8	Discharge Coeff				0.8	Discharge Coeff

HEC-1 Ord	Time After End of DR	Time	Combined Inflow	Flow thru Control	WSEL at Weir	Spill to Meadow	Volume to Meadow	Volume in Meadow	WSEL in Meadow	h_d/H_e	C_s	Spill to Lake	Volume to Lake	Volume in Lake	WSEL in Lake
	(hours)	(hours)	(cfs)	(cfs)	(NAVD)	(cfs)	(ac-ft)	(ac-ft)	(NAVD)			(cfs)	(ac-ft)	(ac-ft)	(NAVD)
165		27.33	687	1155	125.86	-468	-6	508	128.76						128.76
166		27.50	632	1105	125.74	-473	-7	502	128.70						128.70
167		27.67	580	1057	125.63	-477	-7	495	128.64						128.64
168		27.83	528	1011	125.50	-483	-7	489	128.58						128.58
169		28.00	477	963	125.39	-486	-7	482	128.52						128.52
170		28.17	429	920	125.27	-491	-7	475	128.46						128.46
171		28.33	384	879	125.16	-495	-7	468	128.40						128.40
172		28.50	342	840	125.05	-498	-7	462	128.34						128.34
173		28.67	304	804	124.97	-500	-7	455	128.28						128.28
174		28.83	271	773	124.88	-502	-7	448	128.22						128.22
175		29.00	240	743	124.80	-503	-7	441	128.15						128.15
176		29.17	212	716	124.73	-504	-7	434	128.09						128.09
177		29.33	187	691	124.66	-504	-7	427	128.03						128.03
178		29.50	163	668	124.59	-505	-7	420	127.96						127.96
179		29.67	143	648	124.53	-505	-7	413	127.89						127.89
180		29.83	124	627	124.48	-503	-7	406	127.82						127.82
181		30.00	108	609	124.43	-501	-7	399	127.75						127.75
182		30.17	95	595	124.38	-500	-7	392	127.68						127.68
183		30.33	82	579	124.34	-497	-7	385	127.61						127.61
184		30.50	72	567	124.30	-495	-7	379	127.53						127.53
185		30.67	62	554	124.27	-492	-7	372	127.46						127.46
186		30.83	54	544	124.23	-490	-7	365	127.39						127.39
187		31.00	47	534	124.20	-487	-7	358	127.32						127.32
188		31.17	41	524	124.18	-483	-7	352	127.25						127.25
189		31.33	35	515	124.15	-480	-7	345	127.19						127.19
190		31.50	31	508	124.12	-477	-7	339	127.12						127.12
191		31.67	27	500	124.10	-473	-7	332	127.05						127.05
192		31.83	23	492	124.08	-469	-6	326	126.98						126.98
193		32.00	20	486	124.05	-466	-6	319	126.91						126.91
194		32.17	17	478	124.04	-461	-6	313	126.84						126.84
195		32.33	15	472	124.02	-457	-6	307	126.77						126.77
196		32.50	13	466	124.00	-453	-6	300	126.70						126.70
	0	32.67	0	452	123.95	-452	-6	294	126.64						126.64
	0.17	32.83		447	123.94	-447	-6	288	126.57						126.57
	0.33	33.00		443	123.92	-443	-6	282	126.50						126.50
	0.50	33.17		439	123.91	-439	-6	276	126.44						126.44
	0.67	33.33		434	123.89	-434	-6	270	126.37						126.37
	0.83	33.50		429	123.88	-430	-6	264	126.31						126.31
	1.00	33.67		425	123.87	-425	-6	258	126.24						126.24
	1.17	33.83		421	123.85	-421	-6	252	126.18						126.18
	1.33	34.00		417	123.84	-417	-6	246	126.12						126.12
	1.50	34.17		412	123.82	-412	-6	241	126.05						126.05
	1.63	34.30		408	123.81	-408	-4	236	126.00					149	126.00
	1.67	34.33		405	123.80	-405	-1	86	125.96			0	0	149	126.00
	1.83	34.50		402	123.79	-402	-6	81	125.80			-26	0	148	125.99
	2.00	34.67		390	123.75	-390	-5	76	125.65			-60	-1	147	125.98
	2.17	34.83		379	123.72	-379	-5	72	125.52			-78	-1	146	125.96
	2.33	35.00		369	123.68	-369	-5	68	125.40			-90	-1	145	125.94
	2.50	35.17		359	123.65	-360	-5	65	125.28			-100	-1	144	125.91
	2.67	35.33		351	123.62	-351	-5	62	125.18			-108	-1	142	125.89
	2.83	35.50		343	123.59	-343	-5	58	125.08			-115	-2	141	125.86
	3.00	35.67		335	123.56	-335	-5	55	124.98			-120	-2	139	125.83
	3.17	35.83		327	123.53	-327	-5	53	124.87			-125	-2	137	125.80
	3.33	36.00		319	123.50	-319	-4	50	124.78			-131	-2	135	125.76
	3.50	36.17		311	123.47	-311	-4	48	124.69			-135	-2	134	125.73
	3.67	36.33		304	123.44	-304	-4	45	124.60			-139	-2	132	125.69
	3.83	36.50		297	123.42	-297	-4	43	124.52			-142	-2	130	125.66
	4.00	36.67		290	123.39	-290	-4	41	124.45			-145	-2	128	125.62
	4.17	36.83		283	123.37	-283	-4	39	124.38			-147	-2	126	125.59
	4.33	37.00		277	123.35	-277	-4	38	124.32			-149	-2	124	125.55
	4.50	37.17		271	123.32	-271	-4	36	124.26			-151	-2	122	125.51
	4.67	37.33		266	123.30	-266	-4	34	124.20			-153	-2	119	125.47
	4.83	37.50		261	123.28	-260	-4	33	124.14			-154	-2	117	125.44
	5.00	37.67		256	123.26	-256	-4	32	124.09			-155	-2	115	125.40
	5.17	37.83		251	123.24	-251	-3	30	124.04			-156	-2	113	125.36
	5.33	38.00		246	123.22	-246	-3	29	123.99			-156	-2	111	125.32
	5.50	38.17		242	123.20	-242	-3	28	123.93			-157	-2	109	125.28
	5.67	38.33		236	123.18	-236	-3	27	123.87			-158	-2	107	125.24
	5.83	38.50		230	123.16	-230	-3	26	123.82			-159	-2	104	125.20
	6.00	38.67		225	123.14	-225	-3	25	123.77			-160	-2	102	125.16
	6.17	38.83		221	123.12	-221	-3	24	123.73			-160	-2	100	125.12
	6.33	39.00		216	123.10	-216	-3	23	123.69			-161	-2	98	125.08
	6.50	39.17		212	123.08	-212	-3	23	123.65			-161	-2	96	125.04
	6.67	39.33		208	123.06	-208	-3	22	123.61			-161	-2	93	125.00
	6.83	39.50		205	123.05	-205	-3	21	123.58			-160	-2	91	124.96
	7.00	39.67		201	123.03	-201	-3	21	123.55			-160	-2	89	124.92
	7.17	39.83		198	123.02	-198	-3	20	123.52			-159	-2	87	124.88
	7.33	40.00		195	123.01	-195	-3	20	123.49			-158	-2	85	124.84
	7.50	40.17		193	122.99	-193	-3	19	123.47			-158	-2	82	124.79
	7.67	40.33		190	122.98	-190	-3	19	123.44			-157	-2	80	124.75
	7.83	40.50		188	122.97	-188	-3	18	123.42			-156	-2	78	124.71
	8.00	40.67		185	122.96	-185	-3	18	123.40			-155	-2	76	124.67

Creek Weir Length =		900	feet	**Lake Weir Length**		1000	feet	**Meadow**	6	Siphons		**Lake**	3	Siphons	
Weir Elevation =		129.5	NAVD	Weir Elevation =		126	NAVD	**Drain**	36	inch diameter		**Drain**	36	inch diameter	
Coef. Of Discharge =		2.6		Coef. Of Discharge =		2.6			0.8	Discharge Coeff			0.8	Discharge Coeff	

HEC-1 Ord	Time After End of DR	Time	Combined Inflow	Flow thru Control	WSEL at Weir	Spill to Meadow	Volume to Meadow	Volume in Meadow	WSEL in Meadow	h_d/H_e	C_s	Spill to Lake	Volume to Lake	Volume in Lake	WSEL in Lake
	(hours)	(hours)	(cfs)	(cfs)	(NAVD)	(cfs)	(ac-ft)	(ac-ft)	(NAVD)			(cfs)	(ac-ft)	(ac-ft)	(NAVD)
	8.17	40.83		183	122.95	-183	-3	18	123.38			-154	-2	74	124.63
	8.33	41.00		181	122.94	-181	-2	17	123.36			-153	-2	72	124.59
	8.50	41.17		178	122.93	-178	-2	17	123.34			-151	-2	70	124.55
	8.67	41.33		176	122.92	-176	-2	16	123.32			-150	-2	68	124.51
	8.83	41.50		174	122.91	-174	-2	16	123.30			-149	-2	66	124.48
	9.00	41.67		172	122.90	-172	-2	16	123.28			-148	-2	64	124.44
	9.17	41.83		170	122.89	-170	-2	15	123.26			-146	-2	61	124.40
	9.33	42.00		169	122.88	-169	-2	15	123.24			-145	-2	59	124.36
	9.50	42.17		167	122.87	-167	-2	15	123.23			-144	-2	58	124.32
	9.67	42.33		165	122.86	-165	-2	14	123.21			-142	-2	56	124.29
	9.83	42.50		163	122.85	-163	-2	14	123.20			-141	-2	54	124.25
	10.00	42.67		161	122.84	-161	-2	14	123.18			-140	-2	52	124.21
	10.17	42.83		160	122.84	-160	-2	14	123.16			-138	-2	50	124.18
	10.33	43.00		158	122.83	-158	-2	13	123.15			-137	-2	48	124.14
	10.50	43.17		156	122.82	-156	-2	13	123.13			-136	-2	46	124.11
	10.67	43.33		155	122.81	-154	-2	13	123.12			-134	-2	44	124.07
	10.83	43.50		153	122.80	-153	-2	12	123.10			-133	-2	42	124.04
	11.00	43.67		151	122.79	-151	-2	12	123.09			-131	-2	41	124.00
	11.17	43.83		150	122.79	-150	-2	12	123.07			-130	-2	39	123.97
	11.33	44.00		148	122.78	-148	-2	12	123.06			-129	-2	37	123.93
	11.50	44.17		147	122.77	-147	-2	11	123.05			-127	-2	35	123.90
	11.67	44.33		145	122.76	-145	-2	11	123.03			-126	-2	33	123.86
	11.83	44.50		144	122.75	-144	-2	11	123.02			-124	-2	32	123.83
	12.00	44.67		142	122.74	-142	-2	11	123.00			-123	-2	30	123.80
	12.17	44.83		141	122.73	-141	-2	10	122.99			-121	-2	28	123.76
	12.33	45.00		139	122.73	-139	-2	10	122.97			-120	-2	27	123.73
	12.50	45.17		138	122.72	-138	-2	10	122.96			-118	-2	25	123.70
	12.67	45.33		136	122.71	-136	-2	9	122.89			-117	-2	24	123.67
	12.83	45.50		129	122.67	-129	-2	9	122.88			-120	-2	22	123.63
	13.00	45.67		127	122.66	-127	-2	9	122.86			-118	-2	20	123.60
	13.17	45.83		126	122.65	-126	-2	9	122.85			-117	-2	19	123.57
	13.33	46.00		124	122.64	-124	-2	9	122.84			-115	-2	17	123.54
	13.50	46.17		123	122.63	-123	-2	9	122.82			-114	-2	15	123.51
	13.67	46.33		122	122.62	-122	-2	9	122.81			-112	-2	14	123.48
	13.83	46.50		120	122.62	-120	-2	9	122.80			-111	-2	12	123.45
	14.00	46.67		119	122.61	-119	-2	8	122.78			-110	-2	11	123.42
	14.17	46.83		117	122.60	-117	-2	8	122.77			-108	-1	9	123.39
	14.33	47.00		116	122.59	-116	-2	8	122.76			-107	-1	8	123.36
	14.50	47.17		114	122.58	-114	-2	8	122.74			-105	-1	6	123.33
	14.67	47.33		113	122.57	-113	-2	8	122.73			-104	-1	5	123.30
	14.83	47.50		111	122.56	-111	-2	8	122.72			-103	-1	4	123.27
	15.00	47.67		110	122.56	-110	-2	8	122.71			-101	-1	2	123.24
	15.17	47.83		108	122.55	-108	-1	8	122.69			-100	-1	1	123.22
	15.33	48.00		107	122.54	-107	-1	8	122.68			-98	-1	-1	123.19
	15.50	48.17		105	122.53	-105	-1	7	122.58			-40	-1	-1	123.18
	15.67	48.33		94	122.47	-94	-1	5	122.45						123.20
	15.83	48.50		77	122.37	-77	-1	4	122.33						123.20
	16.00	48.67		62	122.28	-62	-1	3	122.24						123.20
	16.17	48.83		49	122.21	-49	-1	3	122.17						123.20
	16.33	49.00		39	122.15	-39	-1	2	122.11						123.20
	16.50	49.17		30	122.10	-30	0	2	122.06						123.20
	16.67	49.33		24	122.06	-24	0	1	122.03						123.20
	16.83	49.50		18	122.02	-18	0	1	122.00						123.20
	17.00	49.67		20	122.04	-20	0	1	121.89						123.20
	17.17	49.83		20	122.04	-20	0	1	121.77						123.20
	17.33	50.00		20	122.04	-20	0	0	121.66						123.20
	17.50	50.17		20	122.04	-20	0	0	121.54						123.20
	17.67	50.33		20	122.04	-20	0	0	121.50						123.20
	17.83	50.50		20	122.04	-20	0	0	121.50						123.20
	18.00	50.67		20	122.04	-20	0	-1	121.50						123.20



WATERSHED MODEL SCHEMATIC

FILE NAME: SCVW\08 – LOWER SILVER CR\REPORT\HYDROLOGY\SCHEMATIC.DWG

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 *****************************************                               ***************************************
 *                                       *                               *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                               *   U.S. ARMY CORPS OF ENGINEERS      *
 *           SEPTEMBER 1990              *                               *   HYDROLOGIC ENGINEERING CENTER     *
 *             VERSION 4.0               *                               *         609 SECOND STREET           *
 *                                       *                               *     DAVIS, CALIFORNIA 95616         *
 *  RUN DATE  06/14/2001  TIME  18:43:21 *                               *         (916) 756-1104              *
 *                                       *                               *                                     *
 *****************************************                               ***************************************




                                        X     X  XXXXXXX   XXXXX               X
                                        X     X  X        X     X             XX
                                        X     X  X        X                    X
                                        XXXXXXX  XXXX     X          XXXXX     X
                                        X     X  X        X                    X
                                        X     X  X        X     X              X
                                        X     X  XXXXXXX   XXXXX              XXX




          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1          ID   LOWER SILVER-THOMPSON CREEK FLOOD HYDROGRAPHS, AUGUST 2000
   2          ID   100YEAR FLOOD PEAKS rainfall 4.2 moisture 2.75,r0.75
   3          ID   URBAN AREA FULLY DEVELOPED BASED ON SAN JOSE 2020 GENERAL PLAN
   4          ID   PREPARED BY SCHAAF & WHEELER TO EXAMINE LAKE CUNNINGHAM STORAGE
              *DIAGRAM
   5          IT      10       0       0     196
   6          IO       5       0
              *  Lake Cunningham Outflow Hydrograph w/ Modified Operation

   7          KK    LAKE  LAKE CUNNINGHAM OUTPUT
   8          BA   26.28
              *
   9          IN      10
              *
  10          QI       0       0       0       1       1       2       5      10      19      32
  11          QI      50      74     101     130     158     186     211     234     254     273
  12          QI     291     312     335     361     392     427     466     511     562     620
  13          QI     684     754     825     893     954    1007    1055    1097    1136    1171
  14          QI    1201    1228    1252    1273    1297    1324    1355    1390    1427    1466
  15          QI    1505    1544    1582    1617    1651    1681    1705    1723    1738    1751
  16          QI    1762    1773    1783    1793    1803    1813    1821    1826    1830    1836
  17          QI    1844    1856    1871    1888    1907    1925    1940    1953    1969    1992
  18          QI    2027    2075    2135    2209    2299    2399    2494    2567    2605    2590
  19          QI    2590    2590    2610    2620    2630    2650    2680    2710    2740    2745
  20          QI    2752    2757    2759    2760    2759    2741    2732    2721    2714    2690
  21          QI    2685    2698    2720    2745    2772    2786    2796    2807    2807    2803
  22          QI    2796    2791    2786    2780    2771    2766    2759    2753    2745    2730
  23          QI    2710    2697    2685    2675    2670    2665    2658    2652    2645    2638
  24          QI    2632    2626    2612    2605    2636    2607    2557    2578    2514    2417
  25          QI    2314    2190    2071    1971    1873    1784    1702    1621    1544    1469
  26          QI    1395    1327    1264    1207    1155    1105    1057    1011     963     920
  27          QI     879     840     804     773     743     716     691     668     648     627
  28          QI     609     595     579     567     554     544     534     524     515     508
  29          QI     500     492     486     478     472     466     452     447     443     439
  30          QI     434     429     425     421     417     412     408     405     402     390
  31          QI     379     369     359     351     343     335     327     319     311     304
  32          QI     297     290     283     277     271     266     261     256     251     246
  33          QI     242     236     230     225     221     216     212     208     205     201
  34          QI     198     195     193     190     188     185     183     181     178     176
  35          QI     174     172     170     169     167     165     163     161     160     158
  36          QI     156     155     153     151     150     148     147     145     144     142
  37          QI     141     139     138     136     129     127     126     124     123     122
  38          QI     120     119     117     116     114     113     111     110     108     107
  39          QI     105      94      77      62      49      39      30      24      18      20
  40          QI      20      20      20      20      20
              *

  41          KK    PT22
  42          KM     ROUTE LAKE OUTFLOW FROM CUNNINGHAM TO S. BABB
  43          RL    .000    .000
  44          RD    4300    .002    .045            TRAP      80    0.75
              *
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


  45          KK    PRUR
  46          KM     HYDROGRAPH FOR RURAL PORTION OF AREA P
  47          BA    0.25     .00     .00
  48          PB     4.2
  49          IN      15
  50          PI    .400   .3500   .3500   .4700   .5300   .6000   .6000   .6200   .5300   .5900
  51          PI    .510   .5600   .7400   .7500   .8000   .8500  1.0400   .9400  1.1200  1.1300
  52          PI   0.920   .8000   .9000   .8800   .8400   .7600   .8200   .7200  1.0300   .8200
  53          PI   0.960  0.9500   .9500   .9400   .9300   .9400   .7200   .9200   .9100   .7400
  54          PI   0.930  0.8200   .8600   .6800   .9400   .8500   .8900   .9200   .9100   .7800
  55          PI    .940  1.1300  1.2300  1.2800  1.5000  1.7000   .8300   .9200  1.0500  1.4300
  56          PI   1.560  1.5600  1.6900  1.9300  1.6200  1.1700  1.7400  2.0600  2.6000  3.1800
  57          PI   3.330  3.2800  1.4400  1.1100  1.0900  1.0600  1.0700  1.1000  1.1700   .8900
  58          PI    .930   .8900   .8200  1.0600   .5200  1.0400   .8500  1.0600   .8600   .8600
  59          PI    .880   .8500   .7200   .7900   .9400   .8400   .0000   .0000   .0000   .0000
  60          LS              94
  61          UC    .650    1.96
              *

  62          KK    PPER
  63          KM     HYDROGRAPH FOR PERVIOUS PORTION OF AREA P
  64          BA    .560     .00     .00
  65          LS              93
  66          UC    .969    2.91
              *

  67          KK    PIMP
  68          KM     HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA P
  69          BA    .300     .00     .00
  70          LS              99
  71          UC    .823    0.55
              *

  72          KK  URBANP
  73          HC       2
              *

  74          KK   PSTOR
  75          KM     ROUTE THRU STORM DRAIN SYSTEM P
  76          RL      0.     .00
  77          RS       1    STOR      0.     .00
  78          SV       0     2.2     6.5     8.6    10.8    17.2    25.8   154.8
  79          SQ       0    24.1    60.2    68.8    76.1    77.4    79.1    79.1
              *

  80          KK    PT22
  81          KM     LOWER SILVER CREEK ABOVE S. BABB CONFLUENCE
  82          HC       3
              *
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 83           KK   Q1RUR
 84           KM     HYDROGRAPH FOR RURAL PORTION OF AREA Q1
 85           BA    1.37     .00     .00
 86           LS              91
 87           UC    .640    1.91
              *

 88           KK   Q2RUR
 89           KM     HYDROGRAPH FOR RURAL PORTION OF AREA Q2
 90           BA    1.79     .00     .00
 91           LS              93
 92           UC    .470    1.40
              *

 93           KK   Q1&Q2
 94           HC       2
              *

 95           KK    CLAY
 96           KM     ROUTE S. BABB CREEK TO CLAYTON ROAD
 97           RL     .00     .00
 98           RD    7000   0.035    0.04            TRAP       3     0.8
              *

 99           KK   SBABB
100           KM     ROUTE S. BABB CREEK TO SILVER CREEK CONFLUENCE
101           RL     .00     .00
102           RD    5000   0.015   0.018            TRAP       4     1.0
              *

103           KK   Q3RUR
104           KM     HYDROGRAPH FOR RURAL PORTION OF AREA Q3
105           BA    0.25     .00     .00
106           LS              94
107           UC    .700    2.09
              *

108           KK   Q3PER
109           KM     HYDROGRAPH FOR PERVIOUS PORTION OF AREA Q3
110           BA    .240     .00     .00
111           LS              93
112           UC    .971    2.91
              *

113           KK   Q3IMP
114           KM     HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA Q3
115           BA    .390     .00     .00
116           LS              99
117           UC    .866    0.58
              *
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 118          KK  URBNQ3
 119          HC       2
              *

 120          KK  Q3STOR
 121          KM     ROUTE THRU STORM DRAIN SYSTEM Q3
 122          RL      0.     .00
 123          RS       1    STOR      0.     .00
 124          SV       0     1.6     4.7     6.3     7.9    12.6    18.9   113.4
 125          SQ       0    17.6    44.1    50.4    53.6    78.8    97.7    97.7
              *

 126          KK   ALLQ3
 127          HC       2
              *

 128          KK   SBABB
 129          KM     INFLOW FROM SOUTH BABB CREEK
 130          HC       2
              *

 131          KK    PT22
 132          KM    SOUTH BABB /LOWER SILVER CONFLUENCE
 133          HC       2
              *

 134          KK    PT23
 135          KM     ROUTE HYDROGRAPH IN SILVER CREEK FROM POINT 22 TO POINT 23
 136          RL     .00     .00
 137          RD    3110   0.002   0.045            TRAP      40    0.75
              *

 138          KK   R1RUR
 139          KM     HYDROGRAPH FOR RURAL PORTION OF AREA R1
 140          BA    0.35     .00     .00
 141          LS              94
 142          UC    .440    1.33
              *

 143          KK   R1PER
 144          KM     HYDROGRAPH FOR PERVIOUS PORTION OF AREA R1
 145          BA    .340     .00     .00
 146          LS              93
 147          UC    .722    2.17
              *

 148          KK   R1IMP
 149          KM     HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA R1
 150          BA    .400     .00     .00
 151          LS              99
 152          UC    .615    0.41
              *
```

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LINE            ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 153            KK  URBNR1
 154            HC       2
                *

 155            KK  R1STOR
 156            KM     ROUTE THRU STORM DRAIN SYSTEM R1
 157            RL      0.     .00
 158            RS       1    STOR      0.     .00
 159            SV       0     1.9     5.6     7.4     9.3    14.8    22.2    59.2    96.2   133.2
 160            SQ       0    20.7    51.8    59.2    62.9    92.5   114.7   266.4   414.4   558.7
                *

 161            KK      R1
 162            HC       2
                *

 163            KK   WHITE
 164            KM     ROUTE HYDROGRAPH IN PIPE FROM POINT R1 TO WHITE ROAD
 165            RL     .00     .00
 166            RD    5300   0.013    .013            CIRC     6.0
                *

 167            KK   NBABB
 168            KM    ROUTE FROM WHITE ROAD TO N BABB CONFLUENCE
 169            RL     .00     .00
 170            RD    1500   0.013    .015            TRAP     4.0     1.0
                *

 171            KK   R2PER
 172            KM     HYDROGRAPH FOR PERVIOUS PORTION OF AREA R2
 173            BA    .530     .00     .00
 174            LS              93
 175            UC    .937    2.81
                *

 176            KK   R2IMP
 177            KM     HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA R2
 178            BA    .310     .00     .00
 179            LS              99
 180            UC    .797    0.53
                *

 181            KK  URBNR2
 182            HC       2
                *

 183            KK  R2STOR
 184            KM     ROUTE THRU STORM DRAIN SYSTEM R2
 185            RL      0.     .00
 186            RS       1    STOR      0.     .00
 187            SV       0     2.1     6.3     8.4    10.5    16.8    25.2   151.2
 188            SQ       0    23.5    58.8    67.2    71.4   105.0   130.2   130.2
                *
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LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 189           KK   R3PER
 190           KM     HYDROGRAPH FOR PERVIOUS PORTION OF AREA R3
 191           BA    .380     .00     .00
 192           LS              93
 193           UC   1.146    3.44
               *

 194           KK   R3IMP
 195           KM     HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA R3
 196           BA    .240     .00     .00
 197           LS              99
 198           UC    .973    0.65
               *

 199           KK  URBNR3
 200           HC       2
               *

 201           KK  R3STOR
 202           KM     ROUTE THRU STORM DRAIN SYSTEM R3
 203           RL      0.     .00
 204           RS       1    STOR      0.     .00
 205           SV       0     1.6     4.7     6.2     7.8    12.4    18.6   111.6
 206           SQ       0    28.5    93.0    14.6   127.1   148.8   173.6   173.6
               *

 207           KK   NBABB
 208           KM    NORTH BABB CREEK INFLOW
 209           HC       3
               *

 210           KK   R4PER
 211           KM     HYDROGRAPH FOR PERVIOUS PORTION OF AREA R4
 212           BA    .190     .00     .00
 213           LS              92
 214           UC   1.006    3.02
               *

 215           KK   R4IMP
 216           KM     HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA R4
 217           BA    .100     .00     .00
 218           LS              99
 219           UC    .797    0.53
               *

 220           KK  URBNR4
 221           HC       2
               *
```

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LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 222           KK  R4STOR
 223           KM     ROUTE THRU STORM DRAIN SYSTEM R4.
 224           RL      0.     .00
 225           RS       1    STOR      0.     .00
 226           SV       0     0.7     2.2     2.9     3.6     5.8     8.7    52.2
 227           SQ       0    13.3    43.5    52.2    59.5    62.4    63.8    63.8
               *

 228           KK    PT23
 229           KM    NORTH BABB CREEK / SILVER CREEK CONFLUENCE
 230           HC       3
               *

 231           KK      4B
 232           KM     ROUTE HYDROGRAPH FROM POINT 23 TO REACH 4B (THRU S1)
 233           RL     .00     .00
 234           RD    1450  0.0032   0.045                TRAP      38    0.75
               *

 235           KK    PT24
 236           KM     ROUTE HYDROGRAPH FROM REACH 4B TO I680 (THRU S1)
 237           RL     .00     .00
 238           RD    2500   0.003   0.045                TRAP      62    0.75
               *

 239           KK   S1PER
 240           KM     HYDROGRAPH FOR PERVIOUS PORTION OF AREA S1
 241           BA    .300     .00     .00
 242           LS                91
 243           UC   1.798    5.40
               *

 244           KK   S1IMP
 245           KM     HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA S1
 246           BA    .080     .00     .00
 247           LS                99
 248           UC   1.497    1.00
               *

 249           KK  URBNS1
 250           HC       2
               *

 251           KK  S1STOR
 252           KM     ROUTE THRU STORM DRAIN SYSTEM S1.
 253           RL      0.     .00
 254           RS       1    STOR      0.     .00
 255           SV       0     1.0     2.9     3.8     4.8     7.6    11.4    68.4
 256           SQ       0    17.5    57.0    68.4    77.9    81.7    83.6    83.6
               *
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 257          KK    PT24
 258          KM    HWY 680
 259          HC       2
              *

 260          KK      3F
 261          KM     ROUTE HYDROGRAPH FROM POINT 24 THRU REACH 3F
 262          RL     .00     .00
 263          RD    1000  0.0028   0.045           TRAP     120     2.0
              *

 264          KK      3E
 265          KM     ROUTE HYDROGRAPH THRU REACH 3E
 266          RL     .00     .00
 267          RD    1150  0.0028   0.045           TRAP      75     2.0
              *

 268          KK    PT25
 269          KM     ROUTE HYDROGRAPH THRU REACH 3D AND 3C TO ALUM ROCK
 270          RL     .00     .00
 271          RD    1400    .004     .04           TRAP      50     0.1
              *

 272          KK   S2PER
 273          KM     HYDROGRAPH FOR PERVIOUS PORTION OF AREA S2
 274          BA    .470     .00     .00
 275          LS                91
 276          UC   1.253    3.76
              *

 277          KK   S2IMP
 278          KM     HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA S2
 279          BA    .250     .00     .00
 280          LS                99
 281          UC   1.068    0.71
              *

 282          KK  URBNS2
 283          HC       2
              *

 284          KK  S2STOR
 285          KM     ROUTE THRU STORM DRAIN SYSTEM S2
 286          RL      0.     .00
 287          RS       1    STOR      0.     .00
 288          SV       0     1.8     5.4     7.2     9.0    14.4    21.6   129.6
 289          SQ       0    20.2    50.4    57.6    61.2    64.8    66.2    66.2
              *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 290          KK    TPER
 291          KM     HYDROGRAPH FOR PERVIOUS PORTION OF AREA T
 292          BA    .550     .00     .00
 293          LS              88
 294          UC   1.304    3.91
              *

 295          KK    TIMP
              *
 296          KM     HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA T
 297          BA    .240     .00     .00
 298          LS              99
 299          UC   1.073    0.72
              *

 300          KK  URBANT
 301          HC       2
              *

 302          KK   TSTOR
 303          KM     ROUTE THRU STORM DRAIN SYSTEM T
 304          RL      0.     .00
 305          RS       1    STOR      0.     .00
 306          SV       0     2.0     5.9     7.8     9.8    15.6    23.4   140.4
 307          SQ       0    21.8    54.6    62.4    66.3    70.2    71.8    71.8
              *

 308          KK    PT25
 309          KM    ALUM ROCK AVE
 310          HC       3
              *

 311          KK      3B
 312          KM     ROUTE HYDROGRAPH FROM POINT 25 THRU REACH 3B
 313          RL     .00     .00
 314          RD    2200  0.0015   0.018            TRAP      58     0.0
              *

 315          KK      3A
 316          KM     ROUTE HYDROGRAPH THRU REACH 3A TO MCKEE
 317          RL     .00     .00
 318          RD    1300  0.0015   0.045            TRAP      75     2.0
              *

 319          KK    PT27
 320          KM     ROUTE HYDROGRAPH THRU REACH 2 TO POINT 27 (MIGUELITA CREEK)
 321          RL     .00     .00
 322          RD    1450    .001    .018            TRAP      45     0.0
              *
```

```
LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 323           KK   U1RUR
 324           KM     HYDROGRAPH FOR RURAL PORTION OF AREA U1
 325           BA    0.75     .00     .00
 326           LS                  92
 327           UC    .420    1.25
               *

 328           KK   U1PER
 329           KM     HYDROGRAPH FOR PERVIOUS PORTION OF AREA U1
 330           BA    .050     .00     .00
 331           LS                  92
 332           UC    .675    2.02
               *

 333           KK   U1IMP
 334           KM     HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA U1
 335           BA    .070     .00     .00
 336           LS                  99
 337           UC    .587    0.39
               *

 338           KK  URBNU1
 339           HC       2
               *

 340           KK  U1STOR
 341           KM     ROUTE THRU STORM DRAIN SYSTEM U1
 342           RL      0.     .00
 343           RS       1    STOR      0.     .00
 344           SV       0     0.3     0.9     1.2     1.5     2.4     3.6     9.6    15.6    21.6
 345           SQ       0     5.5    18.0    21.6    24.6    28.8    33.6    55.8    82.2   162.0
               *

 346           KK      U1
 347           HC       2
               *

 348           KK   MCKEE
 349           KM     ROUTE U1 HYDROGRAPH TO MCKEE ROAD (THRU U2)
 350           RL     .00     .00
 351           RD    3500   0.042    0.04            TRAP       1     0.5
               *

 352           KK    SHOP
 353           KM     ROUTE HYDROGRAPH IN MCKEE ROAD TO SHOPPING CENTER
 354           RL     .00     .00
 355           RD    2000   0.044    .013            TRAP     3.5     0.0
               *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 356          KK     CAP
 357          KM     ROUTE HYDROGRAPH TO CAPITOL EXPRESSWAY
 358          RL     .00     .00
 359          RD    6000   0.012    .013            CIRC      5.
              *

 360          KK    I680
 361          KM     ROUTE HYDROGRAPH TO I680
 362          RL     .00     .00
 363          RD    2000   0.012    .013            CIRC      6.
              *

 364          KK   U2RUR
 365          KM     HYDROGRAPH FOR RURAL PORTION OF AREA U2
 366          BA    0.01     .00     .00
 367          LS              88
 368          UC    .820    2.45
              *

 369          KK   U2PER
 370          KM     HYDROGRAPH FOR PERVIOUS PORTION OF AREA U2
 371          BA    1.11     .00
 372          LS              85
 373          UC   1.140    3.42
              *

 374          KK   U2IMP
 375          KM     HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA U2
 376          BA    .690     .00     .00
 377          LS              99
 378          UC    .985    0.66
              *

 379          KK  URBNU2
 380          HC       2
              *

 381          KK  U2STOR
 382          KM     ROUTE THRU STORM DRAIN SYSTEM U2
 383          RL      0.     .00
 384          RS       1    STOR      0.     .00
 385          SV       0     4.5    13.5    18.0    22.5    36.0    54.0   324.0
 386          SQ       0    50.4   126.0   144.0   153.0   225.0   279.0   279.0
              *

 387          KK   ALLU2
 388          HC       2
              *
```

```
LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 389           KK   I680
 390           HC      2
               *

 391           KK    MIG
 392           KM    ROUTE HYDROGRAPH FROM I680 TO MIGUELITA CONFLUENCE (THRU U3)
 393           RL    .00     .00
 394           RD   6000   0.008    .013            CIRC     6.5
               *

 395           KK  U3PER
 396           KM    HYDROGRAPH FOR PERVIOUS PORTION OF AREA U3
 397           BA   0.49     .00
 398           LS             82
 399           UC  1.278    3.83
               *

 400           KK  U3IMP
 401           KM    HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA U3
 402           BA   .180     .00     .00
 403           LS             99
 404           UC  1.024    0.68
               *

 405           KK URBNU3
 406           HC      2
               *

 407           KK U3STOR
 408           KM    ROUTE THRU STORM DRAIN SYSTEM U3
 409           RL     0.     .00
 410           RS      1    STOR      0.     .00
 411           SV      0     1.7     5.0     6.7     8.4    13.4    20.1   120.6
 412           SQ      0    18.8    46.9    53.6    57.0    83.8   103.9   103.9
               *

 413           KK    MIG
 414           KM    INFLOW FROM MIGUELITA CREEK
 415           HC      2
               *

 416           KK   VPER
 417           KM    HYDROGRAPH FOR PERVIOUS PORTION OF AREA V
 418           BA   .380     .00     .00
 419           LS             86
 420           UC  1.269    3.81
               *

 421           KK   VIMP
 422           KM    HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA V
 423           BA   .170     .00     .00
 424           LS             99
 425           UC  1.075     .72
               *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 426          KK   URBNV
 427          HC       2
              *

 428          KK   VSTOR
 429          KM     ROUTE THRU STORM DRAIN SYSTEM V
 430          RL      0.     .00
 431          RS       1    STOR      0.     .00
 432          SV       0     1.4     4.1     5.5     6.9    11.0    16.5    99.0
 433          SQ       0    25.3    82.5    99.0   112.8   118.3   121.0   121.0
              *

 434          KK    PT27
 435          KM    LOWER SILVER CREEK DOWNSTREAM MIGUELITA
 436          HC       3
              *

 437          KK    PT28
 438          KM    ROUTE LOWER SILVER CREEK FROM MIGUELITA TO HWY 101
 439          RL     .00     .00
 440          RD    1900    .001    .045            TRAP     100    2.00
              *

 441          KK   W1PER
 442          KM     HYDROGRAPH FOR PERVIOUS PORTION OF AREA W1
 443          BA    .990     .00     .00
 444          LS              90
 445          UC   1.579    4.74
              *

 446          KK   W1IMP
 447          KM     HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA W1
 448          BA    .380     .00     .00
 449          LS              99
 450          UC   1.290    0.86
              *

 451          KK  URBNW1
 452          HC       2
              *

 453          KK      W1
 454          KM     ROUTE THRU STORM DRAIN SYSTEM W1.
 455          RL      0.     .00
 456          RS       1    STOR      0.     .00
 457          SV       0     3.4    10.2    13.6    17.0    27.2    40.8   244.8
 458          SQ       0    38.1    95.2   108.8   115.6   170.0   210.8   210.8
              *
```

```
LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 459           KK    RTW1
 460           KM     ROUTE HYDROGRAPH OVERLAND AT 1FPS FROM POINT W1 TO POINT W2 (THRU W2)
 461           RL     .00     .00
 462           RM      10    1.83     0.3
               *

 463           KK   W2PER
 464           KM     HYDROGRAPH FOR PERVIOUS PORTION OF AREA W2
 465           BA    .850     .00     .00
 466           LS              89
 467           UC   1.618    4.85
               *

 468           KK   W2IMP
 469           KM     HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA W2
 470           BA    .470     .00     .00
 471           LS              99
 472           UC   1.329    0.89
               *

 473           KK  URBNW2
 474           HC       2
               *

 475           KK  W2STOR
 476           KM     ROUTE THRU STORM DRAIN SYSTEM W2.
 477           RL      0.     .00
 478           RS       1    STOR      0.     .00
 479           SV       0     3.3     9.9    13.2    16.5    26.4    39.6   237.6
 480           SQ       0    37.0    92.4   105.6   112.2   165.0   204.6   204.6
               *

 481           KK    I680
 482           HC       2
               *

 483           KK    PT28
 484           KM    ROUTE OVERLAND AT 1 FPS THRU W3 TO LOWER SILVER
 485           RL     .00     .00
 486           RM      10    1.81     0.3
               *

 487           KK   W3PER
 488           KM     HYDROGRAPH FOR PERVIOUS PORTION OF AREA W3
 489           BA    0.47     .00
 490           LS              87
 491           UC   1.651   4.950
               *
```

```
LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 492           KK   W3IMP
 493           KM     HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA W3
 494           BA    .290     .00     .00
 495           LS              99
 496           UC   1.386     .92
               *

 497           KK  URBNW3
 498           HC       3
               *

 499           KK  W3STOR
 500           KM     ROUTE THRU STORM DRAIN SYSTEM W3
 501           RL      0.     .00
 502           RS       1    STOR      0.     .00
 503           SV       0     8.6    25.8    34.4    43.0    68.8   103.2   619.2
 504           SQ       0    96.3   240.8   275.2   292.4   309.6   316.5   316.5
               *

 505           KK    XPER
 506           KM     HYDROGRAPH FOR PERVIOUS PORTION OF AREA X
 507           BA    0.18     .00
 508           LS              82
 509           UC   1.260    3.78
               *

 510           KK    XIMP
 511           KM     HYDROGRAPH FOR IMPERVIOUS PORTION OF AREA X
 512           BA    .060     .00     .00
 513           LS              99
 514           UC   1.058     .71
               *

 515           KK   URBNX
 516           HC       2
               *

 517           KK   XSTOR
 518           KM     ROUTE THRU STORM DRAIN SYSTEM X
 519           RL      0.     .00
 520           RS       1    STOR      0.     .00
 521           SV       0     0.6     1.8     2.4     3.0     4.8     7.2    43.2
 522           SQ       0    11.0    36.0    43.2    49.2    51.6    52.8    52.8
               *

 523           KK    PT28
 524           KM    HIGHWAY 101
 525           HC       3
               *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 526          KK   WOOST
 527          KM     ROUTE HYDROGRAPH FROM POINT 28 TO WOOSTER AVENUE
 528          RL     .00     .00
 529          RD     900   0.003    .045            TRAP      80     1.0
              *

 530          KK    PT29
 531          KM     ROUTE HYDROGRAPH FROM WOOSTER TO POINT 29 (COYOTE CREEK)
 532          RL     .00     .00
 533          RD    1100   0.003    .045            TRAP     100     2.0
              *
 534          ZZ
```

```
                SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 'INE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    7        LAKE
                V
                V
   41        PT22
                .
                .
   45           .        PRUR
                .           .
                .           .
   62           .           .        PPER
                .           .           .
                .           .           .
   67           .           .           .        PIMP
                .           .           .           .
                .           .           .           .
   72           .           .      URBANP............
                .           .           V
                .           .           V
   74           .           .       PSTOR
                .           .           .
                .           .           .
   80        PT22........................
                .
                .
   83           .       Q1RUR
                .           .
                .           .
   88           .           .       Q2RUR
                .           .           .
                .           .           .
   93           .       Q1&Q2............
                .           V
                .           V
   95           .        CLAY
                .           V
                .           V
   99           .       SBABB
                .           .
                .           .
  103           .           .       Q3RUR
                .           .           .
                .           .           .
  108           .           .           .       Q3PER
                .           .           .           .
                .           .           .           .
  113           .           .           .           .       Q3IMP
                .           .           .           .           .
                .           .           .           .           .
   18           .           .           .      URBNQ3............
                .           .           .           V
                .           .           .           V
  120           .           .           .      Q3STOR
                .           .           .           .
```

```
               .           .           .           .
126            .           .       ALLQ3............
               .           .           .
               .           .           .
 28            .       SBABB............
               .           .
               .           .
131         PT22............
               V
               V
134         PT23
               .
               .
138            .       R1RUR
               .           .
               .           .
143            .           .       R1PER
               .           .           .
               .           .           .
148            .           .           .       R1IMP
               .           .           .           .
               .           .           .           .
153            .           .      URBNR1............
               .           .           V
               .           .           V
155            .           .      R1STOR
               .           .           .
               .           .           .
161            .          R1............
               .           V
               .           V
163            .       WHITE
               .           V
               .           V
167            .       NBABB
               .           .
               .           .
171            .           .       R2PER
               .           .           .
               .           .           .
176            .           .           .       R2IMP
               .           .           .           .
               .           .           .           .
181            .           .      URBNR2............
               .           .           V
               .           .           V
183            .           .      R2STOR
               .           .           .
               .           .           .
189            .           .           .       R3PER
               .           .           .           .
               .           .           .           .
194            .           .           .           .       R3IMP
               .           .           .           .           .
               .           .           .           .           .
 99            .           .           .      URBNR3............
               .           .           .           V
               .           .           .           V
201            .           .           .      R3STOR
               .           .           .           .
```

Coyote Watershed Program
Lower Silver Creek Reaches 1 thru 6

Composite Roughness Calculations Using Chow Equation (6-19)

Reach 1D

Station 27+71 to Station 32+75

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		2			0.04
Maintenance Road	20				0.03
Grassed Floodplain	15	2		3	0.04
Wetland	50	2	2	3	0.05
Riparian Bench	5				0.15
Right Bank			2		0.15

Total Discharge	**4,920**	cfs
Maximum Depth	**14**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.040	56.25	16.77	3.35	3,151	110	1.96	426
Maintenance Road	0.030	150.00	20.00	7.50	19,158	672	4.48	13,467
Grassed Floodplain	0.040	211.50	21.71	9.74	24,120	846	4.00	13,518
Wetland	0.050	819.00	63.42	12.91	90,164	3,161	3.86	47,093
Riparian Bench	0.150	52.50	5.00	10.50	1,678	59	1.12	74
Right Bank	0.150	110.25	23.48	4.70	2,061	72	0.66	31
Summation		1,399.50	150.37	9.31	140,332	4,920		74,610

Average Velocity	3.52	fps
Composite n	0.044	
α	1.23	

n Used	0.045
α Used	1.2

Coyote Watershed Program
Lower Silver Creek Reaches 1 thru 6

Composite Roughness Calculations Using Chow Equation (6-19)

Reach 1D

Station 32+75 to Station 36+50

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		1.5			0.045
Maintenance Road	20				0.03
Grassed Floodplain	13	1		3	0.04
Wetland	50	2	2	3	0.05
Riparian Bench	5				0.15
Right Bank			2		0.15

Total Discharge	**4,920**	cfs
Maximum Depth	**13.5**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.045	42.19	13.52	3.12	2,002	74	1.75	226
Maintenance Road	0.030	150.00	20.00	7.50	19,158	707	4.71	15,686
Grassed Floodplain	0.040	163.50	17.24	9.48	18,312	675	4.13	11,530
Wetland	0.050	819.00	63.42	12.91	90,164	3,326	4.06	54,854
Riparian Bench	0.150	52.50	5.00	10.50	1,678	62	1.18	86
Right Bank	0.150	110.25	23.48	4.70	2,061	76	0.69	36
Summation		1,337.44	142.66	9.38	133,375	4,920		82,419

Average Velocity	3.68	fps
Composite n	0.045	
α	1.24	

n Used	0.045
α Used	1.25

Coyote Watershed Program
Lower Silver Creek Reaches 1 thru 6

Composite Roughness Calculations Using Chow Equation (6-19)

Reach 3A

Station 54+28 to Station 66+57

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		2			0.04
Maintenance Road	20				0.03
Grassed Floodplain	3	1		2	0.04
Wetland	30	4	2	3	0.05
Riparian Bench	5				0.15
Right Bank			2		0.15

Total Discharge	**4,340**	cfs
Maximum Depth	**14.5**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.040	90.25	21.24	4.25	5,919	211	2.34	1,160
Maintenance Road	0.030	190.00	20.00	9.50	28,408	1,015	5.34	28,951
Grassed Floodplain	0.040	55.50	5.83	9.52	6,233	223	4.01	3,584
Wetland	0.050	669.00	49.08	13.63	76,352	2,727	4.08	45,335
Riparian Bench	0.150	57.50	5.00	11.50	1,953	70	1.21	103
Right Bank	0.150	132.25	25.71	5.14	2,627	94	0.71	47
Summation		1,194.50	126.86	9.42	121,492	4,340		79,180

Average Velocity	3.63	fps
Composite n	0.044	
α	1.38	

n Used	0.045
α Used	1.40

```
              .           .           .           .
207           .       NBABB........................
              .           .
              .           .
 10           .           .       R4PER
              .           .           .
              .           .           .
215           .           .           .       R4IMP
              .           .           .           .
              .           .           .           .
220           .           .      URBNR4............
              .           .           V
              .           .           V
222           .           .      R4STOR
              .           .           .
              .           .           .
228        PT23........................
              V
              V
231          4B
              V
              V
235        PT24
              .
              .
239           .       S1PER
              .           .
              .           .
244           .           .       S1IMP
              .           .           .
              .           .           .
249           .      URBNS1............
              .           V
              .           V
251           .      S1STOR
              .           .
              .           .
257        PT24............
              V
              V
260          3F
              V
              V
264          3E
              V
              V
268        PT25
              .
              .
272           .       S2PER
              .           .
              .           .
277           .           .       S2IMP
              .           .           .
              .           .           .
 82           .      URBNS2............
              .           V
              .           V
284           .      S2STOR
              .           .
              .           .
290           .           .        TPER
              .           .           .
              .           .           .
 95           .           .           .        TIMP
              .           .           .           .
              .           .           .           .
300           .           .      URBANT............
              .           .           V
              .           .           V
302           .           .       TSTOR
              .           .           .
              .           .           .
308        PT25........................
              V
              V
311          3B
              V
              V
315          3A
              V
              V
319        PT27
              .
              .
323           .       U1RUR
              .           .
              .           .
328           .           .       U1PER
              .           .           .
              .           .           .
333           .           .           .       U1IMP
              .           .           .           .
              .           .           .           .
338           .           .      URBNU1............
              .           .           V
              .           .           V
340           .           .      U1STOR
              .           .           .
              .           .           .
346           .          U1............
              .           V
              .           V
348           .       MCKEE
              .           V
              .           V
352           .        SHOP
              .           V
              .           V
356           .         CAP
              .           V
              .           V
360           .        I680
              .           .
              .           .
 64           .           .       U2RUR
              .           .           .
              .           .           .
369           .           .           .       U2PER
              .           .           .           .
              .           .           .           .
374           .           .           .           .       U2IMP
              .           .           .           .           .
              .           .           .           .           .
 79           .           .           .      URBNU2............
              .           .           .           V
              .           .           .           V
381           .           .           .      U2STOR
              .           .           .           .
              .           .           .           .
387           .           .       ALLU2............
              .           .           .
              .           .           .
389           .        I680............
              .           V
              .           V
391           .         MIG
              .           .
              .           .
395           .           .       U3PER
              .           .           .
              .           .           .
400           .           .           .       U3IMP
              .           .           .           .
              .           .           .           .
405           .           .      URBNU3............
              .           .           V
              .           .           V
407           .           .      U3STOR
              .           .           .
              .           .           .
413           .         MIG............
              .           .
              .           .
416           .           .        VPER
              .           .           .
              .           .           .
421           .           .           .        VIMP
              .           .           .           .
              .           .           .           .
426           .           .       URBNV............
              .           .           V
              .           .           V
428           .           .       VSTOR
              .           .           .
              .           .           .
434        PT27........................
              V
              V
437        PT28
              .
              .
441           .       W1PER
              .           .
              .           .
 46           .           .       W1IMP
              .           .           .
              .           .           .
451           .      URBNW1............
              .           V
              .           V
453           .          W1
              .           V
              .           V
 59           .        RTW1
              .           .
              .           .
463           .           .       W2PER
              .           .           .
              .           .           .
468           .           .           .       W2IMP
              .           .           .           .
              .           .           .           .
473           .           .      URBNW2............
              .           .           V
              .           .           V
475           .           .      W2STOR
              .           .           .
              .           .           .
481           .        I680............
              .           V
              .           V
483           .        PT28
              .           .
              .           .
487           .           .       W3PER
              .           .           .
              .           .           .
492           .           .           .       W3IMP
              .           .           .           .
              .           .           .           .
497           .      URBNW3........................
              .           V
              .           V
499           .      W3STOR
              .           .
              .           .
505           .           .        XPER
              .           .           .
              .           .           .
510           .           .           .        XIMP
              .           .           .           .
              .           .           .           .
515           .           .       URBNX............
              .           .           V
              .           .           V
517           .           .       XSTOR
              .           .           .
              .           .           .
523        PT28........................
              V
              V
526       WOOST
              V
              V
 30        PT29

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
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*****************************************                       ***************************************
*                                       *                       *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                       *   U.S. ARMY CORPS OF ENGINEERS      *
*           SEPTEMBER 1990              *                       *   HYDROLOGIC ENGINEERING CENTER     *
*             VERSION 4.0               *                       *         609 SECOND STREET           *
*                                       *                       *      DAVIS, CALIFORNIA 95616        *
*  RUN DATE  06/14/2001  TIME  18:43:21 *                       *          (916) 756-1104             *
*                                       *                       *                                     *
*****************************************                       ***************************************




                              LOWER SILVER-THOMPSON CREEK FLOOD HYDROGRAPHS, AUGUST 2000
                              100YEAR FLOOD PEAKS rainfall 4.2 moisture 2.75,r0.75
                              URBAN AREA FULLY DEVELOPED BASED ON SAN JOSE 2020 GENERAL PLAN
                              PREPARED BY SCHAAF & WHEELER TO EXAMINE LAKE CUNNINGHAM STORAGE

   6 IO          OUTPUT CONTROL VARIABLES
                       IPRNT           5  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                        NMIN          10  MINUTES IN COMPUTATION INTERVAL
                       IDATE      1    0  STARTING DATE
                       ITIME        0000  STARTING TIME
                          NQ         196  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE      2    0  ENDING DATE
                      NDTIME        0830  ENDING TIME
                       ICENT          19  CENTURY MARK

                   COMPUTATION INTERVAL     .17 HOURS
                        TOTAL TIME BASE   32.50 HOURS

          ENGLISH UNITS
               DRAINAGE AREA        SQUARE MILES
               PRECIPITATION DEPTH  INCHES
               LENGTH, ELEVATION    FEET
               FLOW                 CUBIC FEET PER SECOND
               STORAGE VOLUME       ACRE-FEET
               SURFACE AREA         ACRES
               TEMPERATURE          DEGREES FAHRENHEIT
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                                   RUNOFF SUMMARY
                              FLOW IN CUBIC FEET PER SECOND
                           TIME IN HOURS,  AREA IN SQUARE MILES

                               PEAK    TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN    MAXIMUM     TIME OF
OPERATION          STATION     FLOW      PEAK       6-HOUR      24-HOUR     72-HOUR      AREA     STAGE     MAX STAGE

HYDROGRAPH AT         LAKE    2807.     19.50        2749.        2048.       1606.     26.28

ROUTED TO             PT22    2806.     19.83        2749.        2048.       1600.     26.28

HYDROGRAPH AT         PRUR      54.     18.33          40.          23.         17.       .25

HYDROGRAPH AT         PPER     103.     18.67          84.          50.         38.       .56

HYDROGRAPH AT         PIMP      89.     18.33          54.          33.         24.       .30

2 COMBINED AT       URBANP     189.     18.33         135.          81.         62.       .86

ROUTED TO            PSTOR      79.     18.67          79.          73.         60.       .86

3 COMBINED AT         PT22    2927.     19.67        2867.        2140.       1677.     27.39

HYDROGRAPH AT        Q1RUR     284.     18.33         210.         116.         87.      1.37

HYDROGRAPH AT        Q2RUR     420.     18.33         291.         163.        121.      1.79

2 COMBINED AT        Q1&Q2     704.     18.33         501.         279.        208.      3.16

ROUTED TO             CLAY     700.     18.33         501.         279.        208.      3.16

ROUTED TO            SBABB     698.     18.50         501.         279.        208.      3.16

HYDROGRAPH AT        Q3RUR      53.     18.50          40.          23.         17.       .25

HYDROGRAPH AT        Q3PER      44.     18.67          36.          21.         16.       .24

HYDROGRAPH AT        Q3IMP     114.     18.33          70.          42.         31.       .39

2 COMBINED AT       URBNQ3     157.     18.33         103.          63.         48.       .63

ROUTED TO          Q3STOR      98.     18.83          92.          61.         47.       .63

2 COMBINED AT        ALLQ3     148.     18.83         131.          85.         65.       .88

2 COMBINED AT        SBABB     844.     18.50         629.         363.        272.      4.04

2 COMBINED AT         PT22    3665.     18.50        3495.        2501.       1950.     31.43

ROUTED TO             PT23    3664.     18.67        3495.        2500.       1947.     31.43

HYDROGRAPH AT        R1RUR      85.     18.17          58.          33.         24.       .35

HYDROGRAPH AT        R1PER      70.     18.50          53.          31.         23.       .34

HYDROGRAPH AT        R1IMP     127.     18.17          72.          44.         32.       .40

2 COMBINED AT       URBNR1     194.     18.17         122.          73.         55.       .74
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ROUTED TO         R1STOR      120.   19.17        110.        72.        55.        .74

2 COMBINED AT         R1      195.   18.33        164.       104.        79.       1.09

ROUTED TO          WHITE      195.   18.50        164.       104.        79.       1.09

ROUTED TO          NBABB      195.   18.50        164.       104.        79.       1.09

HYDROGRAPH AT      R2PER       99.   18.67         80.        47.        36.        .53

HYDROGRAPH AT      R2IMP       92.   18.33         56.        34.        25.        .31

2 COMBINED AT     URBNR2      189.   18.33        132.        79.        61.        .84

ROUTED TO         R2STOR      127.   20.00        120.        78.        60.        .84

HYDROGRAPH AT      R3PER       66.   18.83         55.        33.        25.        .38

HYDROGRAPH AT      R3IMP       68.   18.33         43.        26.        19.        .24

2 COMBINED AT     URBNR3      132.   18.50         96.        58.        45.        .62

ROUTED TO         R3STOR      127.   18.83         89.        57.        45.        .62

3 COMBINED AT      NBABB      441.   18.83        370.       237.       184.       2.55

HYDROGRAPH AT      R4PER       34.   18.67         28.        16.        12.        .19

HYDROGRAPH AT      R4IMP       30.   18.33         18.        11.         8.        .10

2 COMBINED AT     URBNR4       63.   18.33         45.        27.        20.        .29

ROUTED TO         R4STOR       54.   19.00         44.        26.        20.        .29

3 COMBINED AT       PT23     4157.   18.67       3906.      2764.      2152.      34.27

ROUTED TO             4B     4156.   18.83       3906.      2764.      2151.      34.27

ROUTED TO           PT24     4155.   18.83       3906.      2764.      2148.      34.27

HYDROGRAPH AT      S1PER       41.   19.50         38.        23.        18.        .30

HYDROGRAPH AT      S1IMP       20.   18.67         14.         9.         6.        .08

2 COMBINED AT     URBNS1       59.   19.00         50.        31.        24.        .38

ROUTED TO         S1STOR       57.   19.50         50.        31.        24.        .38

2 COMBINED AT       PT24     4208.   18.83       3954.      2794.      2172.      34.65

ROUTED TO             3F     4206.   18.83       3954.      2794.      2171.      34.65

ROUTED TO             3E     4205.   19.00       3954.      2794.      2170.      34.65

ROUTED TO           PT25     4205.   19.00       3953.      2794.      2169.      34.65

HYDROGRAPH AT      S2PER       76.   19.00         65.        38.        29.        .47

HYDROGRAPH AT      S2IMP       69.   18.50         44.        27.        20.        .25
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  2 COMBINED AT    URBNS2     142.   18.50      106.      64.      49.      .72

  ROUTED TO        S2STOR      66.   19.33       66.      59.      48.      .72

  HYDROGRAPH AT      TPER      81.   19.00       71.      41.      31.      .55

  HYDROGRAPH AT      TIMP      66.   18.50       43.      26.      19.      .24

  2 COMBINED AT    URBANT     144.   18.67      110.      65.      50.      .79

  ROUTED TO         TSTOR      72.   20.17       72.      62.      49.      .79

  3 COMBINED AT      PT25    4341.   19.00     4089.    2908.    2265.    36.16

  ROUTED TO            3B    4340.   19.00     4088.    2908.    2264.    36.16

  ROUTED TO            3A    4337.   19.17     4088.    2908.    2262.    36.16

  ROUTED TO          PT27    4337.   19.17     4088.    2908.    2260.    36.16

  HYDROGRAPH AT     U1RUR     180.   18.17      121.      66.      49.      .75

  HYDROGRAPH AT     U1PER      10.   18.50        8.       4.       3.      .05

  HYDROGRAPH AT     U1IMP      22.   18.17       13.       8.       6.      .07

  2 COMBINED AT    URBNU1      32.   18.17       20.      12.       9.      .12

  ROUTED TO        U1STOR      25.   18.67       20.      12.       9.      .12

  2 COMBINED AT        U1     204.   18.17      141.      78.      58.      .87

  ROUTED TO         MCKEE     204.   18.33      141.      78.      58.      .87

  ROUTED TO          SHOP     203.   18.33      141.      78.      58.      .87

  ROUTED TO           CAP     202.   18.33      141.      78.      58.      .87

  ROUTED TO          I680     201.   18.50      141.      78.      58.      .87

  HYDROGRAPH AT      U2RUR      2.   18.50        1.       1.       1.      .01

  HYDROGRAPH AT      U2PER    162.   18.83      138.      76.      57.     1.11

  HYDROGRAPH AT      U2IMP    195.   18.33      123.      75.      56.      .69

  2 COMBINED AT     URBNU2    350.   18.50      251.     145.     113.     1.80

  ROUTED TO         U2STOR    244.   20.00      230.     144.     112.     1.80

  2 COMBINED AT      ALLU2    245.   20.00      231.     144.     113.     1.81

  2 COMBINED AT       I680    425.   18.67      360.     222.     171.     2.68

  ROUTED TO            MIG    425.   18.67      360.     222.     171.     2.68

  HYDROGRAPH AT      U3PER     62.   19.00       55.      30.      22.      .49

  HYDROGRAPH AT      U3IMP     50.   18.33       32.      20.      15.      .18
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2 COMBINED AT    URBNU3     109.   18.50       83.      47.      37.      .67

ROUTED TO        U3STOR      81.   20.33       76.      47.      37.      .67

2 COMBINED AT       MIG     495.   18.83      434.     268.     207.     3.35

HYDROGRAPH AT      VPER      54.   19.00       47.      27.      20.      .38

HYDROGRAPH AT      VIMP      47.   18.50       30.      18.      14.      .17

2 COMBINED AT     URBNV      98.   18.67       74.      43.      34.      .55

ROUTED TO         VSTOR      89.   19.17       74.      43.      34.      .55

3 COMBINED AT      PT27    4915.   19.00     4591.    3218.    2501.    40.06

ROUTED TO          PT28    4911.   19.17     4590.    3218.    2497.    40.06

HYDROGRAPH AT     W1PER     141.   19.33      127.      76.      58.      .99

HYDROGRAPH AT     W1IMP      99.   18.67       67.      41.      31.      .38

2 COMBINED AT    URBNW1     234.   18.83      187.     113.      89.     1.37

ROUTED TO            W1     179.   20.83      173.     112.      88.     1.37

ROUTED TO          RTW1     179.   22.67      172.     112.      85.     1.37

HYDROGRAPH AT     W2PER     117.   19.33      106.      63.      48.      .85

HYDROGRAPH AT     W2IMP     121.   18.67       83.      51.      38.      .47

2 COMBINED AT    URBNW2     232.   18.83      181.     109.      86.     1.32

ROUTED TO        W2STOR     175.   20.67      167.     108.      85.     1.32

2 COMBINED AT      I680     349.   22.00      333.     219.     170.     2.69

ROUTED TO          PT28     348.   23.83      332.     217.     165.     2.69

HYDROGRAPH AT     W3PER      61.   19.33       56.      33.      25.      .47

HYDROGRAPH AT     W3IMP      74.   18.67       51.      31.      23.      .29

3 COMBINED AT    URBNW3     426.   23.50      402.     276.     213.     3.45

ROUTED TO        W3STOR     315.   28.00      314.     248.     190.     3.45

HYDROGRAPH AT      XPER      23.   19.00       20.      11.       8.      .18

HYDROGRAPH AT      XIMP      17.   18.50       11.       7.       5.      .06

2 COMBINED AT     URBNX      39.   18.67       30.      17.      13.      .24

ROUTED TO         XSTOR      36.   19.17       29.      17.      13.      .24

3 COMBINED AT      PT28    5223.   19.17     4898.    3459.    2699.    43.75

ROUTED TO         WOOST    5222.   19.17     4898.    3459.    2698.    43.75
ROUTED TO          PT29      5220.   19.33        4898.        3459.        2696.       43.75
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                        SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                              (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                     INTERPOLATED TO
                                                                   COMPUTATION INTERVAL
        ISTAQ   ELEMENT     DT      PEAK    TIME TO     VOLUME      DT      PEAK    TIME TO     VOLUME
                                              PEAK                                    PEAK

                          (MIN)     (CFS)     (MIN)       (IN)     (MIN)    (CFS)     (MIN)       (IN)

          PT22  MANE      10.00   2806.29   1190.00      3.07     10.00   2806.29   1190.00      3.07


CONTINUITY SUMMARY (AC-FT) - INFLOW= .4316E+04 EXCESS= .0000E+00 OUTFLOW= .4301E+04 BASIN STORAGE= .1891E+02 PERCENT ERROR=   -.1


          CLAY  MANE       7.48    702.92   1106.30      3.31     10.00    699.65   1100.00      3.31


CONTINUITY SUMMARY (AC-FT) - INFLOW= .5576E+03 EXCESS= .0000E+00 OUTFLOW= .5576E+03 BASIN STORAGE= .9012E-01 PERCENT ERROR=    .0


         SBABB  MANE       4.11    700.03   1106.23      3.31     10.00    697.99   1110.00      3.31


CONTINUITY SUMMARY (AC-FT) - INFLOW= .5576E+03 EXCESS= .0000E+00 OUTFLOW= .5576E+03 BASIN STORAGE= .5797E-01 PERCENT ERROR=    .0


          PT23  MANE       6.31   3664.09   1116.40      3.12     10.00   3663.69   1120.00      3.12


CONTINUITY SUMMARY (AC-FT) - INFLOW= .5238E+04 EXCESS= .0000E+00 OUTFLOW= .5231E+04 BASIN STORAGE= .1197E+02 PERCENT ERROR=   -.1


         WHITE  MANE       4.67    195.21   1110.29      3.67     10.00    195.21   1110.00      3.67


CONTINUITY SUMMARY (AC-FT) - INFLOW= .2135E+03 EXCESS= .0000E+00 OUTFLOW= .2134E+03 BASIN STORAGE= .3314E-01 PERCENT ERROR=    .0


         NBABB  MANE       1.64    195.14   1111.03      3.67     10.00    195.07   1110.00      3.67


CONTINUITY SUMMARY (AC-FT) - INFLOW= .2134E+03 EXCESS= .0000E+00 OUTFLOW= .2134E+03 BASIN STORAGE= .1886E-01 PERCENT ERROR=    .0


            4B  MANE       2.39   4156.38   1125.16      3.16     10.00   4155.75   1130.00      3.16


CONTINUITY SUMMARY (AC-FT) - INFLOW= .5779E+04 EXCESS= .0000E+00 OUTFLOW= .5776E+04 BASIN STORAGE= .4866E+01 PERCENT ERROR=    .0


          PT24  MANE       4.77   4154.98   1131.24      3.16     10.00   4154.79   1130.00      3.16


   TINUITY SUMMARY (AC-FT) - INFLOW= .5776E+04 EXCESS= .0000E+00 OUTFLOW= .5770E+04 BASIN STORAGE= .1006E+02 PERCENT ERROR=   -.1


            3F  MANE       2.48   4207.06   1133.66      3.16     10.00   4205.64   1130.00      3.16
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CONTINUITY SUMMARY (AC-FT) - INFLOW= .5836E+04 EXCESS= .0000E+00 OUTFLOW= .5833E+04 BASIN STORAGE= .5354E+01 PERCENT ERROR=    .0

              3E  MANE         2.50   4205.43   1138.60       3.15      10.00   4205.18   1140.00         3.15

CONTINUITY SUMMARY (AC-FT) - INFLOW= .5832E+04 EXCESS= .0000E+00 OUTFLOW= .5829E+04 BASIN STORAGE= .5301E+01 PERCENT ERROR=    .0

            PT25  MANE         2.09   4204.66   1140.48       3.15      10.00   4204.56   1140.00         3.15

CONTINUITY SUMMARY (AC-FT) - INFLOW= .5828E+04 EXCESS= .0000E+00 OUTFLOW= .5826E+04 BASIN STORAGE= .4530E+01 PERCENT ERROR=    .0

              3B  MANE         2.57   4340.37   1142.72       3.15      10.00   4340.00   1140.00         3.15

CONTINUITY SUMMARY (AC-FT) - INFLOW= .6085E+04 EXCESS= .0000E+00 OUTFLOW= .6081E+04 BASIN STORAGE= .6446E+01 PERCENT ERROR=    .0

              3A  MANE         3.40   4338.02   1144.64       3.15      10.00   4337.07   1150.00         3.15

CONTINUITY SUMMARY (AC-FT) - INFLOW= .6082E+04 EXCESS= .0000E+00 OUTFLOW= .6076E+04 BASIN STORAGE= .8047E+01 PERCENT ERROR=    .0

            PT27  MANE         1.73   4336.75   1148.85       3.15      10.00   4336.65   1150.00         3.15

CONTINUITY SUMMARY (AC-FT) - INFLOW= .6074E+04 EXCESS= .0000E+00 OUTFLOW= .6071E+04 BASIN STORAGE= .4398E+01 PERCENT ERROR=    .0

           MCKEE  MANE         5.15    203.97   1097.75       3.36      10.00    203.53   1100.00         3.36

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1558E+03 EXCESS= .0000E+00 OUTFLOW= .1558E+03 BASIN STORAGE= .5235E-02 PERCENT ERROR=    .0

            SHOP  MANE          .77    203.39   1100.94       3.36      10.00    203.34   1100.00         3.36

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1558E+03 EXCESS= .0000E+00 OUTFLOW= .1558E+03 BASIN STORAGE= .3061E-02 PERCENT ERROR=    .0

             CAP  MANE         5.54    202.61   1103.03       3.36      10.00    201.61   1100.00         3.36

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1558E+03 EXCESS= .0000E+00 OUTFLOW= .1558E+03 BASIN STORAGE= .4681E-02 PERCENT ERROR=    .0

            I680  MANE         1.81    201.65   1103.67       3.36      10.00    201.07   1110.00         3.36

   TINUITY SUMMARY (AC-FT) - INFLOW= .1558E+03 EXCESS= .0000E+00 OUTFLOW= .1558E+03 BASIN STORAGE= .1600E-02 PERCENT ERROR=    .0

             MIG  MANE         5.43    424.90   1124.23       3.21      10.00    424.90   1120.00         3.21
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CONTINUITY SUMMARY (AC-FT) - INFLOW= .4585E+03 EXCESS= .0000E+00 OUTFLOW= .4583E+03 BASIN STORAGE= .2690E+00 PERCENT ERROR=     .0


            PT28  MANE         5.79   4911.24   1151.77      3.14     10.00   4910.87   1150.00        3.14


CONTINUITY SUMMARY (AC-FT) - INFLOW= .6716E+04 EXCESS= .0000E+00 OUTFLOW= .6704E+04 BASIN STORAGE= .1537E+02 PERCENT ERROR=     .0


           WOOST  MANE         1.71   5222.43   1152.11      3.10     10.00   5221.83   1150.00        3.11


CONTINUITY SUMMARY (AC-FT) - INFLOW= .7250E+04 EXCESS= .0000E+00 OUTFLOW= .7246E+04 BASIN STORAGE= .5820E+01 PERCENT ERROR=     .0


            PT29  MANE         2.33   5221.02   1153.90      3.10     10.00   5219.72   1160.00        3.10


CONTINUITY SUMMARY (AC-FT) - INFLOW= .7246E+04 EXCESS= .0000E+00 OUTFLOW= .7240E+04 BASIN STORAGE= .7872E+01 PERCENT ERROR=     .0



*** NORMAL END OF HEC-1 ***
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Coyote Watershed Program

Lower Silver Creek Reaches 1 thru 6

Composite Roughness Calculations Using Chow Equation (6-19)

Reach 1A

Station 0+73 to Station 10+67

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		2			0.04
Maintenance Road	20				0.03
Grassed Floodplain	18	2		3	0.04
Wetland	28	2	2	3	0.05
Riparian Bench	5				0.15
Right Bank			2		0.15

Total Discharge	**5,220**	cfs
Maximum Depth	**16.5**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.040	110.25	23.48	4.70	7,729	236	2.14	1,087
Maintenance Road	0.030	210.00	20.00	10.50	33,565	1,027	4.89	24,532
Grassed Floodplain	0.040	315.00	24.71	12.75	42,976	1,314	4.17	22,886
Wetland	0.050	642.00	41.42	15.50	79,825	2,441	3.80	35,306
Riparian Bench	0.150	67.50	5.00	13.50	2,551	78	1.16	104
Right Bank	0.150	182.25	30.19	6.04	4,028	123	0.68	56
Summation		1,527.00	144.79	10.55	170,676	5,220		83,971

Average Velocity	3.42	fps
Composite n	0.043	
α	1.38	
n Used	0.045	
α Used	1.4	

Coyote Watershed Program
Lower Silver Creek Reaches 1 thru 6

Composite Roughness Calculations Using Chow Equation (6-19)

Reach 1B

Station 11+07 to Station 13+66

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		1			0.045
Maintenance Road	20				0.03
Grassed Floodplain	15	1		3	0.04
Wetland	28	2	2	3	0.05
Riparian Bench	5				0.15
Right Bank			1		0.045

Total Discharge	**5,220**	cfs
Maximum Depth	**14**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.045	32.00	11.31	2.83	1,422	67	2.10	295
Maintenance Road	0.030	160.00	20.00	8.00	21,333	1,007	6.29	39,842
Grassed Floodplain	0.040	193.50	19.24	10.06	22,537	1,063	5.50	32,117
Wetland	0.050	542.00	41.42	13.09	60,198	2,840	5.24	78,010
Riparian Bench	0.150	55.00	5.00	11.00	1,814	86	1.56	207
Right Bank	0.045	60.50	15.56	3.89	3,325	157	2.59	1,055
Summation		1,043.00	112.53	9.27	110,629	5,220		151,526

Average Velocity	5.00	fps
Composite n	0.042	
α	1.16	

n Used	0.045
α Used	1.20

Coyote Watershed Program
Lower Silver Creek Reaches 1 thru 6

Composite Roughness Calculations Using Chow Equation (6-19)

Reach 1C

Station 13+50 to Station 18+00

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		1			0.045
Maintenance Road	20				0.03
Grassed Floodplain	4	0.8		3	0.04
Wetland	28	2	2	3	0.05
Riparian Bench	5				0.15
Right Bank			0.8		0.045

Total Discharge	**5,220**	cfs
Maximum Depth	**14**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.045	32.00	11.31	2.83	1,422	79	2.46	478
Maintenance Road	0.030	160.00	20.00	8.00	21,333	1,182	7.39	64,573
Grassed Floodplain	0.040	66.80	7.84	8.52	6,966	386	5.78	12,895
Wetland	0.050	542.00	41.42	13.09	60,198	3,336	6.16	126,432
Riparian Bench	0.150	55.00	5.00	11.00	1,814	101	1.83	336
Right Bank	0.045	48.40	14.09	3.44	2,449	136	2.80	1,068
Summation		904.20	99.66	9.07	94,181	5,220		205,782

Average Velocity	5.77 fps
Composite n	0.042
α	1.18

n Used	0.045
α Used	1.2

Coyote Watershed Program

Lower Silver Creek Reaches 1 thru 6

Composite Roughness Calculations Using Chow Equation (6-19)

Reach 1C

Station 21+00 to Station 25+00

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		0.3			0.045
Maintenance Road	20				0.03
Grassed Floodplain	0.00001	0		0	0.04
Wetland	50	2	2	3	0.05
Riparian Bench	5				0.15
Right Bank			0.3		0.045

Total Discharge	**4,920**	cfs
Maximum Depth	**14**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.045	18.15	11.48	1.58	547	20	1.10	24
Maintenance Road	0.030	220.00	20.00	11.00	36,271	1,321	6.00	47,615
Grassed Floodplain	0.040	0.00	0.00	11.00	0	0	4.50	0
Wetland	0.050	850.00	63.42	13.40	95,924	3,493	4.11	58,998
Riparian Bench	0.150	55.00	5.00	11.00	1,814	66	1.20	95
Right Bank	0.045	18.15	11.48	1.58	547	20	1.10	24
Summation		1,161.30	111.39	10.43	135,103	4,920		106,756

Average Velocity	4.24	fps
Composite n	0.041	
α	1.21	

n Used	0.040
α Used	1.2

Coyote Watershed Program
Lower Silver Creek Reaches 1 thru 6

Composite Roughness Calculations Using Chow Equation (6-19)

Reach 3C&D

Station 89+08 to Station 103+28

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		1.67			0.045
Maintenance Road	20				0.03
Grassed Floodplain	1E-07	0		0	0.04
Wetland	26	2	2	3	0.05
Riparian Bench	5				0.15
Right Bank			2		0.15

Total Discharge	**4,210**	cfs
Maximum Depth	**11**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.045	53.44	15.57	3.43	2,702	179	3.35	2,003
Maintenance Road	0.030	160.00	20.00	8.00	21,333	1,412	8.83	110,014
Grassed Floodplain	0.040	0.00	0.00	8.00	0	0	6.62	0
Wetland	0.050	400.00	39.42	10.15	37,498	2,482	6.21	95,593
Riparian Bench	0.150	40.00	5.00	8.00	1,067	71	1.77	220
Right Bank	0.150	64.00	17.89	3.58	998	66	1.03	70
Summation		717.44	97.88	7.33	63,598	4,210		207,900

Average Velocity	5.87	fps
Composite n	0.043	
α	1.43	

n Used	0.045
α Used	1.45

Coyote Watershed Program
Lower Silver Creek Reaches 1 thru 6

Composite Roughness Calculations Using Chow Equation (6-19)

Reach 3E

Station 108+84 to Station 115+19

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		2			0.04
Maintenance Road	20				0.03
Grassed Floodplain	22	2		2	0.04
Wetland	26	4	2	3	0.05
Riparian Bench	5				0.15
Right Bank			2		0.15

Total Discharge	**4,210**	cfs
Maximum Depth	**10.5**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.040	30.25	12.30	2.46	1,378	81	2.67	575
Maintenance Road	0.030	110.00	20.00	5.50	11,425	669	6.08	24,778
Grassed Floodplain	0.040	191.00	26.47	7.22	17,829	1,044	5.47	31,235
Wetland	0.050	435.00	45.08	9.65	39,434	2,310	5.31	65,154
Riparian Bench	0.150	37.50	5.00	7.50	958	56	1.50	126
Right Bank	0.150	56.25	16.77	3.35	840	49	0.88	38
Summation		860.00	125.62	6.85	71,864	4,210		121,906

Average Velocity	4.90	fps
Composite n	0.043	
α	1.21	
n Used	0.045	
α Used	1.20	

Coyote Watershed Program
Lower Silver Creek Reaches 1 thru 6

Composite Roughness Calculations Using Chow Equation (6-19)

Reach 3F

Station 117+33 to Station 124+66

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		2			0.04
Maintenance Road	20				0.03
Grassed Floodplain	51	2		2	0.04
Wetland	26	4	2	3	0.05
Riparian Bench	5				0.15
Right Bank			2		0.15

Total Discharge	**4,210**	cfs
Maximum Depth	**10.0**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.040	25.00	11.18	2.24	1,069	54	2.17	255
Maintenance Road	0.030	100.00	20.00	5.00	9,747	495	4.95	12,105
Grassed Floodplain	0.040	381.00	55.47	6.87	34,416	1,747	4.58	36,713
Wetland	0.050	413.00	45.08	9.16	36,167	1,836	4.44	36,257
Riparian Bench	0.150	35.00	5.00	7.00	854	43	1.24	66
Right Bank	0.150	49.00	15.65	3.13	699	35	0.72	19
Summation		1,003.00	152.38	6.58	82,951	4,210		85,416

Average Velocity	4.20 fps
Composite n	0.042
α	1.15
n Used	0.045
α Used	1.20

Coyote Watershed Program
Lower Silver Creek Reaches 1 thru 6

Composite Roughness Calculations Using Chow Equation (6-19)

Reach 4B

Station 132+10 to Station 153+80

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		0.25			0.045
Maintenance Road	20				0.03
Grassed Floodplain	1E-08	0		0	0.04
Wetland	49	0.25	0.25	2.5	0.05
Riparian Bench	5				0.15
Right Bank			0.25		0.045

Total Discharge	**4,160**	cfs
Maximum Depth	**11.5**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.045	10.13	9.28	1.09	239	12	1.17	16
Maintenance Road	0.030	180.00	20.00	9.00	25,960	1,293	7.19	66,770
Grassed Floodplain	0.040	0.00	0.00	9.00	0	0	5.39	0
Wetland	0.050	576.31	54.15	10.64	55,767	2,778	4.82	64,564
Riparian Bench	0.150	45.00	5.00	9.00	1,298	65	1.44	134
Right Bank	0.045	10.13	9.28	1.09	239	12	1.17	16
Summation		821.56	97.71	8.41	83,502	4,160		131,501

Average Velocity	5.06	fps
Composite n	0.041	
α	1.23	

n Used	0.040
α Used	1.25

Coyote Watershed Program
Lower Silver Creek Reaches 1 thru 6

Composite Roughness Calculations Using Chow Equation (6-19)

Reach 4C

Station 157+61 to Station 170+50

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		0.25			0.045
Maintenance Road	20				0.03
Grassed Floodplain	1E-08	0		0	0.04
Wetland	21	0.25	0.25	2.5	0.05
Riparian Bench	5				0.15
Right Bank			0.25		0.045

Total Discharge	**4,160**	cfs
Maximum Depth	**12.0**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.045	11.28	9.79	1.15	276	21	1.84	70
Maintenance Road	0.030	190.00	20.00	9.50	28,408	2,138	11.25	270,870
Grassed Floodplain	0.040	0.00	0.00	9.50	0	0	8.44	0
Wetland	0.050	265.44	26.15	10.15	24,885	1,873	7.06	93,289
Riparian Bench	0.150	47.50	5.00	9.50	1,420	107	2.25	542
Right Bank	0.045	11.28	9.79	1.15	276	21	1.84	70
Summation		525.50	70.74	7.43	55,265	4,160		364,841

Average Velocity	7.92	fps
Composite n	0.036	
α	1.40	

n Used	0.040
α Used	1.40

Coyote Watershed Program

Lower Silver Creek Reaches 1 thru 6

Composite Roughness Calculations Using Chow Equation (6-19)

Reach 5B

Station 170+50 to Station 180+25

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		0.25			0.045
Maintenance Road	20				0.03
Grassed Floodplain	1E-08	0		0	0.04
Wetland	22	0.8	0.8	2.5	0.05
Riparian Bench	5				0.15
Right Bank			0.25		0.045

Total Discharge	**3,670**	cfs
Maximum Depth	**12.5**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.045	12.50	10.31	1.21	316	18	1.42	36
Maintenance Road	0.030	200.00	20.00	10.00	30,944	1,739	8.70	131,579
Grassed Floodplain	0.040	0.00	0.00	10.00	0	0	6.52	0
Wetland	0.050	320.00	28.40	11.27	32,164	1,808	5.65	57,720
Riparian Bench	0.150	50.00	5.00	10.00	1,547	87	1.74	263
Right Bank	0.045	12.50	10.31	1.21	316	18	1.42	36
Summation		595.00	74.02	8.04	65,287	3,670		189,635

Average Velocity	6.17	fps
Composite n	0.037	
α	1.36	

n Used	0.040
α Used	1.35

Coyote Watershed Program
Lower Silver Creek Reaches 1 thru 6

Composite Roughness Calculations Using Chow Equation (6-19)

Reach 5C

Station 183+28 to Station 201+68

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		0.25			0.045
Maintenance Road	20				0.03
Grassed Floodplain	1E-08	0		0	0.04
Wetland	36	0.8	0.8	2.5	0.05
Riparian Bench	5				0.15
Right Bank			0.25		0.045

Total Discharge	**3,670**	cfs
Maximum Depth	**12.5**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.045	12.50	10.31	1.21	316	14	1.10	17
Maintenance Road	0.030	200.00	20.00	10.00	30,944	1,351	6.75	61,626
Grassed Floodplain	0.040	0.00	0.00	10.00	0	0	5.07	0
Wetland	0.050	495.00	42.40	11.67	50,946	2,224	4.49	44,896
Riparian Bench	0.150	50.00	5.00	10.00	1,547	68	1.35	123
Right Bank	0.045	12.50	10.31	1.21	316	14	1.10	17
Summation		770.00	88.02	8.75	84,068	3,670		106,679

Average Velocity	4.77	fps
Composite n	0.039	
α	1.28	

n Used	0.040
α Used	1.30

Coyote Watershed Program

Lower Silver Creek Reaches 1 thru 6

Composite Roughness Calculations Using Chow Equation (6-19)

Reach 6A

Station 201+68 to Station 217+19

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		0.25			0.045
Maintenance Road	20				0.03
Grassed Floodplain	1E-08	0		0	0.04
Wetland	36	0.8	0.8	2.5	0.05
Riparian Bench	5				0.15
Right Bank			0.25		0.045

Total Discharge	**2,810**	cfs
Maximum Depth	**12.0**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.045	11.28	9.79	1.15	276	10	0.88	8
Maintenance Road	0.030	190.00	20.00	9.50	28,408	1,024	5.39	29,761
Grassed Floodplain	0.040	0.00	0.00	9.50	0	0	4.04	0
Wetland	0.050	475.00	42.40	11.20	47,561	1,715	3.61	22,346
Riparian Bench	0.150	47.50	5.00	9.50	1,420	51	1.08	60
Right Bank	0.045	11.28	9.79	1.15	276	10	0.88	8
Summation		735.06	86.99	8.45	77,941	2,810		52,182

Average Velocity	3.82	fps
Composite n	0.039	
α	1.27	

n Used	0.040
α Used	1.30

Coyote Watershed Program
Lower Silver Creek Reaches 1 thru 6

Composite Roughness Calculations Using Chow Equation (6-19)

Reach 6B

Station 218+20 to Station 230+09

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		0.25			0.045
Maintenance Road	20				0.03
Grassed Floodplain	1E-08	0		0	0.04
Wetland	56	0.8	0.8	2.5	0.05
Riparian Bench	5				0.15
Right Bank			0.25		0.045

Total Discharge	**2,810**	cfs
Maximum Depth	**12.5**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.045	12.50	10.31	1.21	316	8	0.64	3
Maintenance Road	0.030	200.00	20.00	10.00	30,944	784	3.92	12,033
Grassed Floodplain	0.040	0.00	0.00	10.00	0	0	2.94	0
Wetland	0.050	745.00	62.40	11.94	77,831	1,971	2.65	13,799
Riparian Bench	0.150	50.00	5.00	10.00	1,547	39	0.78	24
Right Bank	0.045	12.50	10.31	1.21	316	8	0.64	3
Summation		1,020.00	108.02	9.44	110,954	2,810		25,862

Average Velocity	2.75	fps
Composite n	0.041	
α	1.21	

n Used	0.040
α Used	1.20

Coyote Watershed Program
Lower Silver Creek Reaches 1 thru 6
Composite Roughness Calculations Using Chow Equation (6-19)

Reach 6C

Station 231+94 to Station 241+05

Channel Element	b	Left SS	Right SS	depth	n
Left Bank		0.25			0.045
Maintenance Road	20				0.03
Grassed Floodplain	1E-08	0		0	0.04
Wetland	30	0.8	0.8	2.5	0.05
Riparian Bench	5				0.15
Right Bank			2		0.15

Total Discharge	**2,810**	cfs
Maximum Depth	**11.5**	feet

Element	n_i	A_i	P_i	R_i	$P_iR_i^{5/3}/n_i$	Q_i	V_i	$V_i^3A_i$
Left Bank	0.045	10.13	9.28	1.09	239	10	1.00	10
Maintenance Road	0.030	180.00	20.00	9.00	25,960	1,103	6.13	41,442
Grassed Floodplain	0.040	0.00	0.00	9.00	0	0	4.60	0
Wetland	0.050	386.00	36.40	10.60	37,261	1,583	4.10	26,645
Riparian Bench	0.150	45.00	5.00	9.00	1,298	55	1.23	83
Right Bank	0.150	81.00	20.12	4.02	1,366	58	0.72	30
Summation		702.13	90.80	7.73	66,124	2,810		68,209

Average Velocity	4.00	fps
Composite n	0.042	
α	1.52	
n Used	0.045	
α Used	1.50	

From: "Aldean, Jay/RNO" <jaldean@CH2M.com>
To: "Chuck Anderson (E-mail)" <canderson@swsv.com>
Date: 10/31/01 7:59AM
Subject: FW: Composite Freeboard Computation

Chuck, here is the NRCS memo approving the composite method for determining channel freeboard.

-----Original Message-----
From: Bill Ward [mailto:Bill.Ward@ca.usda.gov]
Sent: October 17, 2001 10:15 AM
To: Aldean, Jay/RNO
Cc: George Fowler (E-mail); Connie Eichhorn (E-mail); Charles Davis
Subject: Composite Freeboard Computation

Hi Jay,

We have determined that using a composite freeboard based on weighting the conveyance for individual channel areas within a section is a good approach for multi-staged channels and recommend its use in these cases. To meet NRCS Criteria you can simply use this procedure and replace the energy head with depth.

Of course the minimum freeboard should also not be less than 1 ft. and other requirements for freeboard (superelevation, unstable range) are on top of the calculated composite freeboard.

If you have any further questions please let me know.

Bill Ward P.E.
Design Staff Leader
NRCS, Davis, CA
(530) 792-5616

USDA
Natural Resources Conservation Service
430 G Street #4164.
Davis, California 95616

Speed Memo

(530) 792-5616, Fax 792-5791

To: Jay Aldean, Lower Silver Creek Project Manager **Date:** 10/10/01

From: Bill Ward, Design Staff Leader

Subject: NRCS Freeboard Requirements

Jay,

As requested, enclosed are the documents where NRCS channel freeboard requirements are defined. Hydraulic design critieria including freeboard is defined in our National Conservation Practice Standard No. 582, "Open Channels." In the practice standard, hydraulic criteria including freeboard is to meet the criteria in Technical Release 25, Design of Open Channels.

To summarize the freeboard criteria in TR-25 is as follows:

Subcritical Channel

Trapezoidal channel = 20% of the design depth
Rectangular lined channel = 10 % of design depth

Supercritical Channel

Trapezoidal Channel = 25% of design depth
Rectangular Channel = 20 % of design depth.

It is important to note that these freeboard requirements are in addition to any freeboard requirements for superelevation, or for being in the unstable slope range ($.7s_c<s_o<1.3\ s_c$).

Freeboard for superelevation or channel slope in this unstable range can be calculated using guidance in TR-25 page 5-4.

If you have any further questions please let me know.

Bill Ward

3pp

Santa Clara Valley Water District

MEMORANDUM

FC 14A (06-28-93)

TO: David Chesterman

FROM: Randy Talley

SUBJECT: Calculation of Channel Freeboard Using Composite Methods in Adobe Creek Reach 5

DATE: August 2, 1999

The purpose of this memorandum is to suggest one method of calculating the required freeboard in the compound channel proposed for Adobe Creek downstream of Edith Road (Reach 5).

The channel modification proposed in Reach 5 is an incised three-stage channel (cross-section attached) with a low-flow channel sized for the 1.5-year or bankfull flow, a densely vegetated midbank bench 3 feet above the low-flow channel, and a wide high-flow bench for any flows exceeding the capacity of the first two. Because these three areas of the channel cross-section have different characteristics, we are suggesting one way to establish freeboard requirements would be to calculate each area separately then put together into a composite number, similar to the composite "n" value (Manning's Roughness) commonly used.

The policy that establishes freeboard is Engineering Policy 3-218, dated September 16, 1994 (copy attached). The Reach 5 channel type is addressed in Policy Procedure B—Design Water Surface Below Natural Ground, and requires freeboard be the greater of 1 foot or two-tenths of the total energy.

The method suggested is to divide the channel cross-section into the three distinct areas (corresponding to the three stages of the channel) and calculate the energy for each area (see attached cross-section). After results are obtained for the three areas, they are multiplied by the proportion of the total discharge they carry and the results are added. An example is attached. I believe this approach complies with the District's policy, and gives appropriate weight to the different channel stages without skewing the results toward the deepest sections.

If you have any further questions, please feel free to call myself at extension 2611 or Scott Wilson at extension 2621.

ORIGINAL SIGNED BY

Engineering Unit Manager
Flood Management Policy and Planning Unit

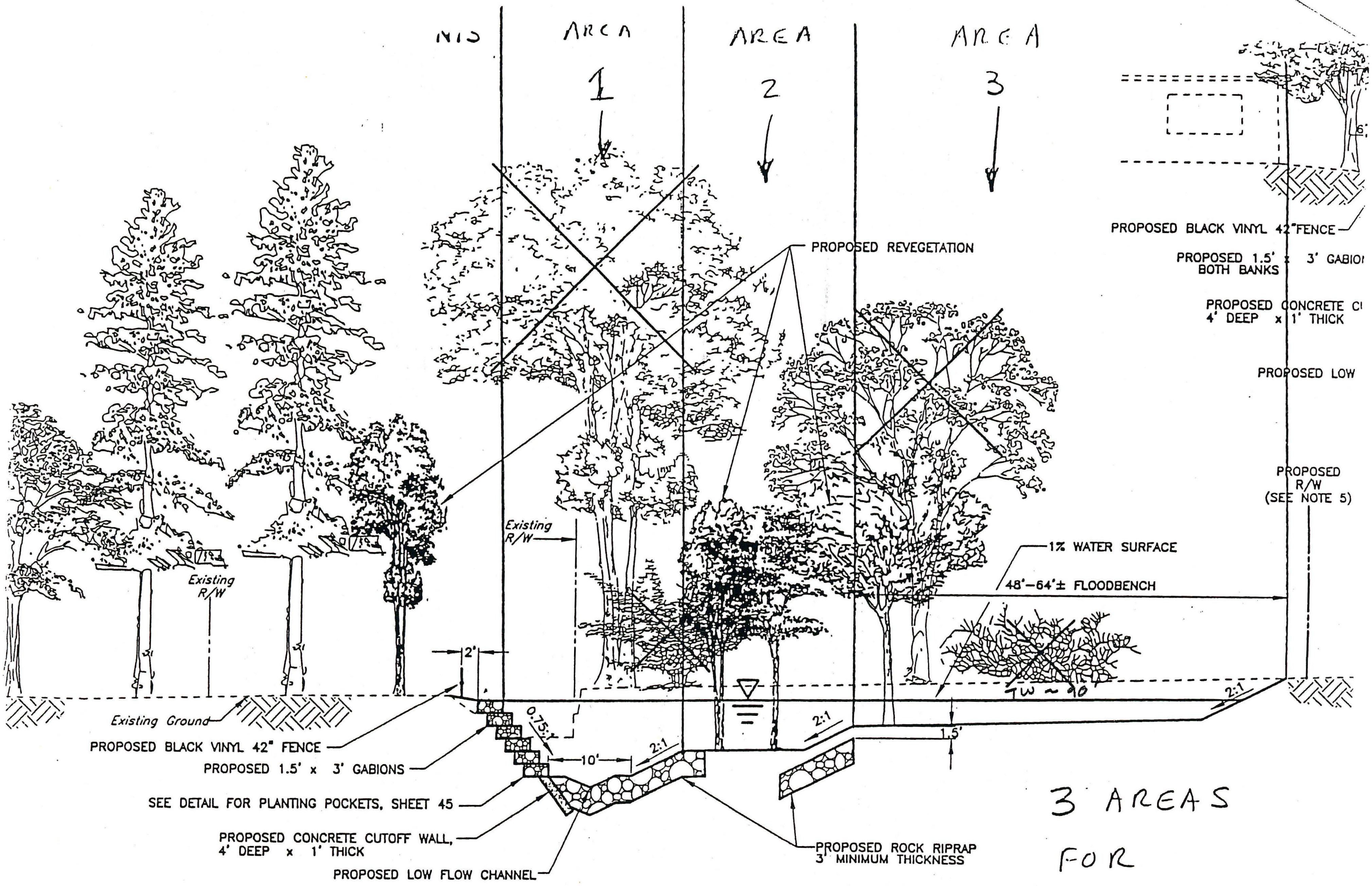
Attachments

cc: R. Talley (w/att)
S. Wilson (w/att)
N. Hsueh (w/att)
D. Hook (w/att)
K. Uyeda (w/att)

SW:nn

0802a

E-22



SECTION (C/36) STA. 392+00± TO STA. 398+00±
(SEE NOTE 1)

(APPROX. SCALE: 1"=15')

3 AREAS
FOR
ANALYSIS
WITH
HEC-RAS

Santa Clara Valley Water District
5750 Almaden Expressway, San Jose 95118, Phone 265-2600

Charge No. ____

By S. WILSON

Date 7/29/99

Subject ADOBE CREEK REACH 5
COMPOSITE FREEBOARD CALCULATION

Checked by ____ Date 7/29/99

EXAMPLE CALCULATION

AREA 1 -

59.6 % OF FLOW = 1728 CFS

DEPTH = 7.8' (D)

VELOCITY = 4.7 FT/SEC (V)

A = 368 ft²

per new policy.

$$\text{FREEBOARD}_1 = .2\left(D + \cancelto{\phi}{\frac{V^2}{2g}}\right) = .2\left(7.8 + \cancelto{\phi}{\frac{(4.7)^2}{64.4}}\right) = \cancel{1.63'}\ 1.56'$$

AREA 2 -

38.9 % FLOW = 1128 CFS

D = 4.2'   V = 4.5 ft/sec

A = 251 ft²

$$F_2 = .2\left(4.2 + \cancelto{\phi}{\frac{(4.5)^2}{64.4}}\right) = 0.90' \quad 0.86'$$

AREA 3 - 18

1.5 % FLOW = 44 CFS

D = 2.0'   V = 2.5 ft/sec

A = 18 ft²

$$F_3 = .2\left(2.0 + \cancelto{\phi}{\frac{(2.5)^2}{64.4}}\right) = 0.42' \quad 0.40'$$

COMPOSITE FREEBOARD -

$$F_c = (\%1 \times F_1) + (\%2 \times F_2) + (\%3 \times F_3)$$

A_{TOT} = 637 ft²
T.W. = 90' ±
d_h = 637 ft²/7.0ft = 7.0 ft

$$F_c = (0.596 \times \overset{1.56}{\cancel{1.63}}) + (0.389 \times \overset{0.86}{\cancel{0.90}}) + (0.015 \times \overset{0.40}{\cancel{0.42}})$$

$$\boxed{F_c = 1.33'}$$

1.27'
conveyance

0.2 × 7.41 = 1.4'
hydraulic depth

$$\left\{\Delta = \frac{1.4 - 1.3}{1.3} = 8\%\right\}\ \underline{\text{OK}}-$$

Freeboard based on Hydraulic Depth - Verification

Station	Flow (cfs)	Hydraul. Depth (ft)	Channel Velocity (ft/s)	0.2* Hyd. Depth (ft)	
7800	4340	10.6	7.04	**2.12**	**= Freeboard**
		max depth	Channel Velocity		
		13.08	7.04	2.62	

Freeboard based on Flow Distribution: Station 7800 LOB = 5, CHAN = 10, ROB = 5

Left Station (ft)	Right Station (ft)	Flow (cfs)	Depth (ft)	Velocity (ft/s)	% Conv.	0.2*Depth (ft)	% Total
LB 970.90	976.72	172.58	8.10	3.67	3.98	1.62	0.06
976.72	982.54	319.62	8.28	6.64	7.36	1.66	0.12
982.54	988.36	332.03	8.60	6.63	7.65	1.72	0.13
988.36	994.18	463.71	10.59	7.52	10.68	2.12	0.23
994.18	1000.00	521.69	11.10	8.07	12.02	2.22	0.27
1000	1005.82	521.69	11.10	8.07	12.02	2.22	0.27
1005.82	1011.64	521.69	11.10	8.07	12.02	2.22	0.27
1011.64	1017.46	524.89	11.36	7.94	12.09	2.27	0.27
1017.46	1023.28	657.26	12.88	8.77	15.14	2.58	0.39
1023.28	RB 1029.10	304.83	12.84	4.08	7.02	2.57	0.18
		4339.99				**Freeboard =**	**2.19**

Freeboard based on Flow Distribution: Station 7950 LOB = 10, CHAN = 20, ROB = 10

Left Station (ft)	Right Station (ft)	Flow (cfs)	Depth (ft)	Velocity (ft/s)	% Conv.	0.2* D (ft)	% Total
LB 970.90	974	59.68	8.01	2.57	1.38	1.60	0.02
973.81	976.72	150.54	8.19	6.32	3.47	1.64	0.06
976.72	979.63	152.32	8.25	6.35	3.51	1.65	0.06
979.63	982.54	154.12	8.31	6.38	3.55	1.66	0.06
982.54	985.45	155.92	8.36	6.41	3.59	1.67	0.06
985.45	988.36	162.43	8.83	6.32	3.74	1.77	0.07
988.36	991.27	201.51	10.12	6.84	4.64	2.02	0.09
991.27	994.18	244.61	11.06	7.60	5.64	2.21	0.12
994.18	997.09	250.10	11.10	7.74	5.76	2.22	0.13
997.09	1000.00	250.09	11.10	7.74	5.76	2.22	0.13
1000.00	1002.91	250.09	11.10	7.74	5.76	2.22	0.13
1002.91	1005.82	250.10	11.10	7.74	5.76	2.22	0.13
1005.82	1008.73	250.09	11.10	7.74	5.76	2.22	0.13
1008.73	1011.64	250.10	11.10	7.74	5.76	2.22	0.13
1011.64	1014.55	250.09	11.10	7.74	5.76	2.22	0.13
1014.55	1017.46	253.33	11.62	7.49	5.84	2.32	0.14
1017.46	1020.37	307.55	12.82	8.25	7.09	2.56	0.18
1020.37	1023.28	322.91	12.94	8.57	7.44	2.59	0.19
1023.28	1026.19	322.91	12.94	8.57	7.44	2.59	0.19
1026.19	RB 1029.10	101.49	12.74	2.74	2.34	2.55	0.06
		4339.98				**Freeboard =**	**2.20**

Conclusion: Hydraulic Depth is a Reasonable Approximation of Depth Weighted by Conveyance.

Difference = -4%

LOWER SILVER CREEK REACHES 1 THRU 6

HYDRAULIC SUMMARY FOR PROPOSED CHANNEL IMPROVEMENTS

	Channel Parameters				Design Parameters						Program Freeboard Requirements			
Location	River Station	Channel Invert (NAVD)	LOB Elev[1] (NAVD)	ROB Elev[1] (NAVD)	10% WSEL (NAVD)	1% WSEL (NAVD)	Chan Velocity (fps)	a	E.G. Elev (NAVD)	Froude Number	Hydraulic Depth (ft)	0.2* D (ft)	Freeboard Line (NAVD)	Max. Wall Height[2] (feet)
Coyote Creek	73	63.70	84.0	74.0	79.75	84.75	0.80	1.40	84.76	0.04	14.28	2.86	87.75	no wall
	104	64.00	84.0	75.0	79.74	84.75	1.04	1.40	84.77	0.05	14.50	2.90	87.75	no wall
	106	65.00	84.0	75.0	79.73	84.75	1.06	1.40	84.77	0.05	14.27	2.85	87.75	no wall
	200	65.37	85.0	76.0	79.72	84.74	1.42	1.40	84.78	0.07	12.89	2.58	87.74	no wall
	400	66.14	83.2	82.0	79.79	84.74	1.50	1.40	84.79	0.07	10.94	2.19	87.74	no wall
	500	66.53	84.7	82.5	79.85	84.74	1.54	1.40	84.79	0.07	10.77	2.15	87.74	no wall
	600	66.92	85.6	84.2	79.88	84.74	1.76	1.40	84.81	0.09	10.41	2.08	87.74	no wall
	700	67.31	86.8	85.0	79.93	84.74	1.94	1.40	84.82	0.10	10.65	2.13	86.87	no wall
	830	67.82	88.0	86.0	80.06	84.75	1.96	1.40	84.83	0.10	8.88	1.78	86.53	no wall
	860	67.93	88.0	86.1	80.13	84.77	1.87	1.40	84.85	0.09	10.45	2.09	86.86	no wall
	930	68.21	88.0	86.2	80.19	84.78	1.99	1.40	84.87	0.10	11.88	2.38	87.16	no wall
	1025	68.21	89.7	88.5	80.24	84.78	2.39	1.40	84.90	0.12	13.25	2.65	87.43	no wall
	1067	68.74	89.9	90.4	80.17	84.77	2.90	1.40	84.95	0.14	12.64	2.53	87.30	no wall
Wooster	1107	68.90	89.9	90.4	80.38	84.93	2.90	1.20	85.09	0.14	12.63	2.53	87.46	no wall
	1120	68.95	90.0	90.5	80.41	84.93	2.91	1.20	85.09	0.14	12.60	2.52	87.45	no wall
	1148	69.06	86.9	88.5	80.64	84.98	2.53	1.20	85.10	0.13	12.15	2.43	87.41	no wall
	1253	69.47	89.0	88.0	80.91	85.02	2.28	1.20	85.12	0.12	11.69	2.34	87.36	no wall
	1273	69.55	89.1	88.1	80.93	85.03	2.29	1.20	85.13	0.12	11.62	2.32	87.35	no wall
	1350	69.85	88.0	88.4	80.68	84.97	3.64	1.20	85.22	0.20	10.75	2.15	87.12	no wall
	1390	70.00	89.5	89.7	80.64	84.94	4.47	1.20	85.31	0.24	11.06	2.21	87.15	no wall
UPRR	1410	70.08	89.9	89.6	82.05	85.11	4.40	1.20	85.47	0.23	11.18	2.24	87.35	no wall
	1450	70.24	89.9	89.6	82.26	85.15	4.42	1.20	85.51	0.23	11.12	2.22	87.37	no wall
	1525	70.53	89.2	85.0	83.21	85.39	3.18	1.20	85.58	0.17	10.88	2.18	88.39	no wall
	1622	70.91	88.5	85.4	83.45	85.46	2.91	1.20	85.62	0.16	10.53	2.11	88.46	no wall
	1667	71.08	89.6	87.0	83.46	85.46	3.23	1.20	85.65	0.18	10.17	2.03	87.49	no wall
	1763	71.46	89.6	87.0	83.63	85.50	3.34	1.20	85.71	0.19	9.91	1.98	87.48	no wall
	1845	71.78	88.0	87.0	83.78	85.54	3.48	1.20	85.77	0.18	11.14	2.23	87.77	no wall
	1884	71.92	87.8	88.4	83.69	85.51	4.42	1.20	85.87	0.24	10.32	2.06	87.57	no wall
	1885	71.92	87.8	88.4	83.70	85.51	4.42	1.20	85.87	0.24	10.32	2.06	87.57	no wall
Highway 101	2045	72.32	90.1	90.1	84.16	85.93	4.43	1.20	86.30	0.24	10.67	2.13	88.06	no wall
	2046	72.32	90.2	90.2	84.16	85.93	4.43	1.20	86.30	0.24	10.68	2.14	88.07	no wall
	2075	72.42	88.8	90.0	84.36	86.12	6.73	1.20	86.96	0.37	10.49	2.10	88.22	no wall
	2120	72.47	87.2	89.5	84.87	86.61	4.38	1.20	86.97	0.22	12.85	2.57	89.18	1.98
	2220	72.58	86.6	89.6	85.01	86.75	3.74	1.20	87.01	0.19	12.60	2.52	89.75	3.15
	2280	72.65	86.6	89.8	85.01	86.74	4.20	1.20	87.07	0.21	11.24	2.25	89.74	3.14
	2525	72.93	87.8	87.8	85.16	86.88	4.26	1.20	87.22	0.21	12.25	2.45	89.33	1.53
	2625	73.04	88.1	87.6	85.25	86.97	4.06	1.20	87.28	0.21	11.65	2.33	89.30	1.70
	2775	73.21	88.6	88.0	85.43	87.14	3.39	1.20	87.35	0.19	9.83	1.97	89.11	1.11
	3000	73.47	88.0	87.8	85.59	87.27	3.25	1.20	87.47	0.18	9.61	1.92	89.19	1.39
	3200	73.69	88.2	88.8	85.71	87.36	3.44	1.20	87.58	0.19	9.84	1.97	89.33	1.13
	3282	73.78	88.3	88.9	85.76	87.40	3.45	1.25	87.63	0.19	9.81	1.96	89.36	1.07
	3300	73.80	88.0	88.5	85.77	87.40	3.56	1.25	87.65	0.20	10.29	2.06	89.46	1.46
	3500	74.02	88.2	88.0	85.90	87.52	3.59	1.25	87.77	0.20	10.20	2.04	89.56	1.56
	3626	74.16	88.3	88.1	85.99	87.59	3.62	1.25	87.84	0.20	10.15	2.03	89.62	1.48
	3671	74.21	88.0	88.2	86.05	87.65	3.38	1.25	87.87	0.18	10.63	2.13	89.78	1.78
	3771	74.32	88.0	88.3	86.08	87.66	3.86	1.25	87.95	0.21	10.61	2.12	89.78	1.78
Miguelita Creek	3828	74.38	88.2	88.6	85.83	87.33	8.25	1.00	88.39	0.40	12.97	2.59	89.92	1.72
	4100	74.65	89.0	89.0	86.18	87.76	7.15	1.00	88.55	0.35	13.20	2.64	90.40	1.40
	4300	74.85	89.0	89.0	86.27	87.84	7.19	1.00	88.64	0.35	13.13	2.63	90.47	1.47
	4500	75.05	89.0	89.0	86.36	87.92	7.23	1.00	88.73	0.35	13.05	2.61	90.53	1.53
	4700	75.25	89.0	89.0	86.45	88.00	7.27	1.00	88.82	0.36	12.98	2.60	90.60	1.60
	4900	75.45	89.0	89.0	86.54	88.08	7.31	1.00	88.91	0.36	12.90	2.58	90.66	1.66
	5030	75.58	89.5	89.5	86.61	88.15	7.33	1.00	88.98	0.36	12.86	2.57	90.72	1.22
Walgreens	5070	75.62	89.6	90.0	86.63	88.17	7.34	1.00	89.01	0.36	12.86	2.57	90.74	1.14
	5100	75.65	89.6	92.0	86.63	88.18	7.34	1.00	89.02	0.36	12.85	2.57	90.75	1.15
	5105	75.65	89.0	92.0	86.60	88.15	7.57	1.00	89.04	0.38	12.48	2.50	90.65	1.65
	5174	75.77	90.2	92.0	86.63	88.18	7.60	1.00	89.08	0.38	12.41	2.48	90.66	0.46
	5240	75.96	90.4	92.0	86.66	88.21	7.73	1.00	89.14	0.39	12.03	2.41	90.62	0.22
McKee	5428	76.35	90.0	90.0	89.89	90.28	7.32	1.40	91.44	0.36	12.70	2.54	94.28	4.28
	5490	76.47	90.0	91.0	90.55	91.11	3.79	1.40	91.42	0.20	8.19	1.64	95.11	5.11
	5527	76.53	90.5	91.5	90.56	91.13	3.84	1.40	91.45	0.22	8.26	1.65	95.13	4.63
	5660	76.78	90.7	92.2	90.68	91.25	3.53	1.40	91.52	0.20	8.59	1.72	94.25	3.51
	5900	77.23	90.0	92.6	90.80	91.39	3.48	1.40	91.65	0.20	3.74	0.75	94.39	4.39
	6028	77.47	91.5	92.8	90.94	91.55	2.55	1.40	91.69	0.15	4.47	0.89	94.55	3.05
	6116	77.64	91.7	91.7	90.99	91.60	2.33	1.40	91.72	0.13	5.14	1.03	92.63	0.96
	6200	77.80	91.2	92.5	91.00	91.60	2.79	1.40	91.77	0.15	6.38	1.28	94.60	3.39
	6437	78.24	92.1	92.1	91.04	91.63	3.81	1.40	91.95	0.22	7.09	1.42	93.05	0.98
	6657	78.65	93.1	92.9	91.17	91.76	4.13	1.40	92.13	0.24	9.02	1.80	93.56	0.71
	6723	78.78	92.5	92.5	91.22	91.81	4.26	1.40	92.20	0.25	9.03	1.81	93.62	1.12
	6823	78.96	92.0	92.3	91.16	91.75	5.28	1.40	92.36	0.29	9.98	2.00	93.75	1.75
	6880	79.07	92.0	92.0	91.07	91.62	6.38	1.00	92.25	0.33	11.68	2.34	93.96	1.96
	7128	79.54	92.7	92.3	91.13	91.69	6.55	1.00	92.36	0.34	11.39	2.28	93.97	1.67
	7428	80.11	94.0	92.5	91.20	91.77	6.76	1.00	92.48	0.36	11.03	2.21	93.98	1.48
	7600	80.44	93.5	93.0	91.26	91.84	6.88	1.00	92.58	0.37	10.84	2.17	94.01	1.01
	7800	80.82	93.0	93.0	91.31	91.90	7.04	1.00	92.67	0.38	10.60	2.12	94.02	1.02
	8040	81.27	94.0	93.5	91.38	91.98	7.26	1.00	92.80	0.40	10.27	2.05	94.03	0.52
	8128	81.44	94.0	93.0	91.41	92.02	7.35	1.00	92.86	0.41	10.14	2.03	94.05	1.05

LOWER SILVER CREEK REACHES 1 THRU 6

HYDRAULIC SUMMARY FOR PROPOSED CHANNEL IMPROVEMENTS

	Channel Parameters				Design Parameters						Program Freeboard Requirements			
Location	River Station	Channel Invert	LOB Elev[1]	ROB Elev[1]	10% WSEL	1% WSEL	Chan Velocity	α	E.G. Elev	Froude Number	Hydraulic Depth	0.2* D	Freeboard Line	Max. Wall Height[2]
		(NAVD)	(NAVD)	(NAVD)	(NAVD)	(NAVD)	(fps)		(NAVD)		(ft)	(ft)	(NAVD)	(feet)
	8040	81.27	94.0	93.5	91.38	91.98	7.26	1.00	92.80	0.40	10.27	2.05	94.03	0.52
	8128	81.44	94.0	93.0	91.41	92.02	7.35	1.00	92.86	0.41	10.14	2.03	94.05	1.05
	8300	81.77	94.0	95.7	91.47	92.08	7.55	1.00	92.97	0.42	9.88	1.98	94.06	0.06
	8500	82.15	95.0	96.2	91.54	92.16	7.78	1.00	93.10	0.44	9.59	1.92	94.08	no wall
	8700	82.53	95.6	97.2	91.62	92.25	8.03	1.00	93.25	0.46	9.30	1.86	94.11	no wall
	8756	82.63	96.1	97.2	91.64	92.27	8.14	1.00	93.30	0.47	9.17	1.83	94.10	no wall
	8763	82.65	98.0	98.0	91.70	92.33	8.10	1.00	93.35	0.47	9.22	1.84	94.17	no wall
Alum Rock	8863	82.84	96.5	97.0	91.89	92.52	8.10	1.00	93.54	0.47	9.22	1.84	94.36	no wall
	8908	82.94	96.0	96.5	92.06	92.77	7.26	1.45	93.96	0.47	7.37	1.47	94.24	no wall
	8908	82.94	96.0	96.5	92.14	92.85	7.18	1.45	94.01	0.46	7.44	1.49	94.34	no wall
	9100	83.61	96.6	96.6	92.89	93.58	7.12	1.45	94.72	0.46	7.49	1.50	95.08	no wall
	9230	84.06	97.1	97.1	93.38	94.08	7.07	1.45	95.21	0.46	7.26	1.45	95.53	no wall
	9325	84.39	97.5	97.5	93.73	94.44	7.75	1.45	95.79	0.52	6.87	1.37	95.81	no wall
	9337	84.43	97.5	97.5	93.40	94.14	9.53	1.45	96.18	0.68	6.02	1.20	96.18	no wall
	9387	84.60	98.0	98.0	94.61	95.18	7.35	1.45	96.40	0.40	10.58	2.12	97.30	no wall
Sunset	9498	84.83	98.0	98.0	95.11	95.80	7.10	1.45	96.94	0.38	10.97	2.19	97.99	no wall
	9559	85.07	98.1	98.1	95.17	95.93	6.74	1.45	96.95	0.42	7.94	1.59	97.52	no wall
	9572	85.12	98.1	98.1	95.28	96.05	6.28	1.45	96.94	0.39	7.99	1.60	97.65	no wall
	9800	86.08	99.1	99.1	95.89	96.66	6.57	1.45	97.63	0.42	7.71	1.54	98.20	no wall
	10000	86.92	98.4	99.3	96.50	97.27	6.77	1.45	98.30	0.43	7.52	1.50	98.77	0.37
	10200	87.76	100.8	100.8	97.16	97.94	6.93	1.45	99.02	0.45	7.38	1.48	99.42	no wall
	10300	88.17	100.7	101.2	97.51	98.29	6.98	1.45	99.39	0.45	7.33	1.47	99.76	no wall
	10349	88.31	100.8	101.3	97.65	98.42	6.62	1.45	99.41	0.42	7.83	1.57	99.99	no wall
	10446	88.58	101.0	102.0	97.46	98.18	9.14	1.45	100.06	0.52	9.60	1.92	100.10	no wall
San Antonio	10556	88.88	102.0	101.2	97.80	98.52	9.09	1.20	100.06	0.52	9.64	1.93	100.45	no wall
	10630	89.08	101.3	101.0	98.25	99.14	7.64	1.20	100.23	0.50	7.13	1.43	100.57	no wall
	10671	89.19	101.4	101.1	98.96	99.84	5.42	1.20	100.39	0.35	7.43	1.49	101.33	0.22
	10884	89.79	101.0	101.5	99.50	100.34	4.83	1.20	100.77	0.32	7.19	1.44	101.78	0.78
	11100	90.39	101.5	105.0	99.88	100.69	5.01	1.20	101.16	0.33	5.86	1.17	101.86	0.36
	11300	90.94	102.3	103.0	100.27	101.04	5.16	1.20	101.54	0.35	6.85	1.37	102.41	0.11
	11519	91.54	104.0	104.2	100.74	101.47	5.29	1.20	101.99	0.36	6.71	1.34	102.81	no wall
	11733	92.13	103.5	105.5	101.29	102.00	4.26	1.20	102.34	0.29	6.70	1.34	103.34	no wall
	11800	92.32	102.3	104.3	101.38	102.08	4.33	1.20	102.43	0.30	6.62	1.32	103.40	1.10
	11900	92.59	102.6	104.6	101.53	102.22	4.42	1.20	102.58	0.30	6.51	1.30	103.52	0.92
	12100	93.15	103.4	104.0	101.86	102.53	4.59	1.20	102.92	0.32	6.30	1.26	103.79	0.39
	12250	93.56	103.8	104.0	102.14	102.79	4.71	1.20	103.20	0.33	6.17	1.23	104.02	0.22
	12350	93.84	104.0	104.0	102.56	103.19	4.47	1.20	103.56	0.30	6.85	1.37	104.56	0.56
	12450	94.12	104.0	104.0	102.67	103.29	5.17	1.20	103.79	0.36	6.46	1.29	104.58	0.58
	12500	94.26	108.0	110.0	101.67	102.04	12.29	1.20	104.85	0.78	7.78	1.56	104.85	no wall
I680	12794	94.15	110.0	110.0	104.32	105.18	8.68	1.00	106.35	0.46	11.03	2.21	107.39	no wall
	12795	94.15	110.0	110.0	104.32	105.18	8.68	1.00	106.35	0.46	11.03	2.21	107.39	no wall
	12829	94.20	108.2	106.3	104.52	105.40	8.00	1.00	106.39	0.42	11.20	2.24	107.64	1.34
	12880	94.34	107.3	105.8	105.17	106.13	4.73	1.00	106.48	0.25	11.13	2.23	110.13	4.33
	13013	94.72	107.5	106.7	105.19	106.14	4.89	1.00	106.51	0.26	10.76	2.15	108.29	1.59
	13035	94.78	107.5	106.7	105.14	106.09	5.39	1.00	106.54	0.28	11.31	2.26	108.35	1.65
Jackson	13125	95.05	107.5	106.7	105.62	106.82	5.18	1.25	107.34	0.27	11.77	2.35	110.82	4.12
	13126	95.05	107.5	106.7	105.61	106.81	5.29	1.25	107.35	0.27	11.76	2.35	110.81	4.11
	13210	95.30	107.2	106.2	105.74	106.95	5.02	1.25	107.44	0.27	10.14	2.03	110.95	4.71
	13300	95.57	107.2	106.3	105.85	107.04	5.11	1.25	107.55	0.28	9.97	1.99	110.04	3.73
	13400	95.87	106.9	107.0	105.95	107.14	5.21	1.25	107.67	0.29	9.51	1.90	110.14	3.20
	13500	96.17	107.8	107.6	106.07	107.24	5.32	1.25	107.79	0.30	9.84	1.97	109.21	1.65
	13600	96.47	107.8	107.7	106.20	107.36	5.42	1.25	107.93	0.31	9.66	1.93	109.29	1.61
	13700	96.77	108.3	108.2	106.34	107.48	5.52	1.25	108.07	0.32	9.50	1.90	109.38	1.19
	13800	97.07	109.3	109.0	106.49	107.61	5.62	1.25	108.22	0.32	9.34	1.87	109.48	0.47
	13900	97.37	109.9	108.5	106.65	107.75	5.72	1.25	108.39	0.33	9.18	1.84	109.59	1.12
	14000	97.67	109.7	108.5	106.82	107.89	5.82	1.25	108.55	0.34	9.04	1.81	109.70	1.16
	14100	97.97	110.9	109.9	106.99	108.05	5.91	1.25	108.73	0.35	8.90	1.78	109.83	no wall
	14200	98.27	111.1	111.2	107.18	108.21	6.01	1.25	108.91	0.36	8.77	1.75	109.96	no wall
	14300	98.57	109.9	110.8	107.37	108.38	6.09	1.25	109.10	0.37	8.65	1.73	110.11	0.21
	14400	98.87	110.2	110.9	107.58	108.56	6.18	1.25	109.30	0.37	8.54	1.71	110.27	0.09
	14500	99.17	110.8	110.8	107.79	108.75	6.26	1.25	109.51	0.38	8.43	1.69	110.44	no wall
	14600	99.47	110.9	111.3	108.02	108.95	6.34	1.25	109.73	0.39	8.34	1.67	110.62	no wall
	14700	99.77	111.4	111.3	108.25	109.15	6.41	1.25	109.95	0.39	8.25	1.65	110.80	no wall
	14800	100.07	111.9	112.2	108.49	109.37	6.48	1.25	110.19	0.40	8.17	1.63	111.00	no wall
	14900	100.37	112.4	111.9	108.73	109.59	6.54	1.25	110.42	0.41	8.09	1.62	111.21	no wall
	15000	100.67	113.1	112.5	108.98	109.82	6.60	1.25	110.67	0.41	8.03	1.61	111.43	no wall
	15100	100.97	114.1	113.5	109.23	110.06	6.65	1.25	110.92	0.42	7.97	1.59	111.65	no wall
	15200	101.27	114.1	114.1	109.50	110.30	6.70	1.25	111.17	0.42	7.91	1.58	111.88	no wall
	15300	101.57	115.5	115.3	109.76	110.54	6.75	1.25	111.42	0.42	7.86	1.57	112.11	no wall
	15380	101.81	116.8	116.8	109.98	110.75	6.77	1.25	111.64	0.43	7.83	1.57	112.32	no wall
	15469	102.08	117.2	114.8	109.83	110.52	9.85	1.25	112.40	0.60	8.44	1.69	112.40	no wall
	15470	102.08	117.2	114.8	109.83	110.53	9.85	1.25	112.41	0.60	8.45	1.69	112.41	no wall
Capitol	15668	103.30	115.5	115.5	110.98	111.75	9.84	1.40	113.85	0.60	8.45	1.69	113.85	no wall
	15669	103.30	115.5	115.5	110.99	111.76	9.84	1.40	113.86	0.60	8.46	1.69	113.86	no wall
	15761	103.60	117.0	117.3	111.10	111.86	12.62	1.40	115.32	0.87	6.58	1.32	115.32	no wall

LOWER SILVER CREEK REACHES 1 THRU 6

HYDRAULIC SUMMARY FOR PROPOSED CHANNEL IMPROVEMENTS

	Channel Parameters				Design Parameters						Program Freeboard Requirements			
Location	River Station	Channel Invert	LOB Elev[1]	ROB Elev[1]	10% WSEL	1% WSEL	Chan Velocity	a	E.G. Elev	Froude Number	Hydraulic Depth	0.2* D	Freeboard Line	Max. Wall Height[2]
		(NAVD)	(NAVD)	(NAVD)	(NAVD)	(NAVD)	(fps)		(NAVD)		(ft)	(ft)	(NAVD)	(feet)
	16200	105.03	118.3	117.3	115.21	115.93	8.98	1.40	117.68	0.53	9.01	1.80	117.73	0.43
	16300	105.35	118.8	117.7	115.69	116.42	8.81	1.40	118.11	0.51	9.17	1.83	118.25	0.53
	16400	105.68	119.1	118.1	116.14	116.88	8.68	1.40	118.52	0.50	9.28	1.86	118.74	0.64
	16500	106.00	118.9	118.4	116.57	117.33	8.57	1.40	118.93	0.49	9.40	1.88	119.21	0.83
	16600	106.33	118.9	118.3	116.98	117.74	8.49	1.40	119.31	0.49	9.47	1.89	119.63	1.38
	16700	106.65	119.2	118.2	117.38	118.15	8.41	1.40	119.69	0.48	8.71	1.74	119.89	1.69
	16800	106.98	119.9	119.1	117.77	118.55	8.35	1.40	120.07	0.47	9.62	1.92	120.47	1.35
	16900	107.32	120.8	119.1	118.14	118.94	8.31	1.40	120.44	0.47	9.66	1.93	120.87	1.74
	17000	107.67	122.3	120.0	118.51	119.31	8.29	1.40	120.80	0.47	9.68	1.94	121.25	1.24
N Babb	17050	107.76	121.0	122.9	118.72	119.52	8.21	1.40	120.99	0.46	9.82	1.96	121.48	0.48
	17125	108.03	121.0	121.0	119.30	120.19	6.39	1.40	121.08	0.35	10.31	2.06	122.25	1.25
Granite Creek	17200	108.18	122.6	120.4	119.48	120.36	6.37	1.35	121.21	0.35	10.32	2.06	122.42	2.02
	17450	108.68	122.8	121.3	120.04	120.89	6.35	1.35	121.74	0.35	10.35	2.07	122.96	1.66
	17700	109.19	123.2	121.7	120.60	121.42	6.34	1.35	122.26	0.35	10.36	2.07	123.49	1.79
	17863	109.51	123.8	121.4	120.94	121.75	6.34	1.35	122.59	0.35	9.32	1.86	124.75	3.35
	18025	109.84	123.8	122.0	121.29	122.08	6.34	1.35	122.92	0.35	9.28	1.86	126.08	4.08
	18193	110.18	124.1	122.3	121.64	122.42	6.33	1.35	123.26	0.35	9.28	1.86	126.42	4.12
	18205	110.20	122.0	125.0	121.63	122.41	6.48	1.35	123.29	0.34	11.11	2.22	126.41	4.41
Story	18310	110.41	122.5	125.5	122.18	123.16	6.33	1.30	123.97	0.33	11.36	2.27	127.16	4.66
	18328	110.45	126.9	126.0	122.52	123.51	4.50	1.30	123.92	0.23	11.50	2.30	125.81	no wall
	18523	110.84	126.2	125.6	122.70	123.67	4.59	1.30	124.10	0.24	11.32	2.26	125.93	0.33
	18718	111.23	125.7	125.1	122.88	123.83	4.68	1.30	124.27	0.25	11.09	2.22	126.05	0.95
	18913	111.62	126.9	125.0	123.07	124.01	4.78	1.30	124.47	0.26	10.89	2.18	126.19	1.19
	19108	112.02	126.9	125.3	123.27	124.20	4.87	1.30	124.68	0.26	10.70	2.14	126.34	1.04
	19308	112.42	127.4	125.8	123.49	124.41	4.96	1.30	124.91	0.27	10.52	2.10	126.51	0.71
	19508	112.82	127.2	127.2	123.73	124.63	5.04	1.30	125.14	0.28	10.37	2.07	126.70	no wall
	19708	113.22	128.1	127.7	123.97	124.86	5.13	1.30	125.39	0.28	10.20	2.04	126.90	no wall
	19908	113.62	128.6	128.9	124.24	125.10	5.21	1.30	125.65	0.29	10.06	2.01	127.11	no wall
	19931	113.67	127.0	128.0	124.15	125.02	6.29	1.30	125.82	0.36	9.57	1.91	126.93	no wall
Murtha	19981	113.77	127.0	128.0	124.17	125.43	6.10	1.30	126.18	0.34	9.87	1.97	127.40	0.40
	19983	113.77	127.7	128.5	124.40	125.63	5.02	1.30	126.14	0.27	10.41	2.08	127.71	0.01
	20168	113.95	129.7	129.0	124.66	125.85	5.00	1.30	126.35	0.27	10.46	2.09	127.94	no wall
	20418	114.2	129.0	128.9	125.10	126.26	3.77	1.30	126.55	0.20	10.59	2.12	128.38	no wall
	20668	114.45	128.7	129.7	125.31	126.42	3.80	1.30	126.71	0.21	10.51	2.10	128.52	no wall
	20918	114.7	129.6	129.7	125.51	126.58	3.84	1.30	126.88	0.21	10.40	2.08	128.66	no wall
	21168	114.94	129.4	128.9	125.72	126.74	3.86	1.30	127.04	0.21	10.36	2.07	128.81	no wall
	21396	115.17	132.0	129.8	125.92	126.91	3.89	1.30	127.22	0.21	10.29	2.06	128.97	no wall
	21665	115.44	132.4	130.0	126.14	127.09	3.92	1.30	127.40	0.22	10.21	2.04	129.13	no wall
	21719	115.49	128.4	128.4	125.95	126.90	6.48	1.30	127.75	0.34	11.41	2.28	129.18	0.83
Moss Point	21780	115.54	128.4	128.4	126.56	127.46	6.20	1.20	128.18	0.32	11.92	2.38	129.84	1.49
	21820	115.58	131.0	131.8	127.12	128.00	2.76	1.20	128.14	0.14	11.25	2.25	130.25	no wall
	22070	115.8	130.7	131.2	127.20	128.07	2.79	1.20	128.22	0.15	11.13	2.23	130.30	no wall
	22320	116.03	132.0	130.2	127.28	128.15	2.83	1.20	128.30	0.15	10.98	2.20	130.35	0.15
	22570	116.25	131.8	129.2	127.37	128.22	2.87	1.20	128.37	0.15	10.83	2.17	130.39	1.19
	22820	116.48	131.6	131.2	127.46	128.30	2.91	1.20	128.46	0.16	10.69	2.14	130.44	no wall
	23009	116.65	131.9	129.8	127.54	128.37	2.94	1.20	128.53	0.16	10.60	2.12	130.49	0.69
	23091	116.72	131.0	131.6	127.46	128.29	4.68	1.20	128.70	0.26	9.71	1.94	130.23	no wall
Ocala	23173	116.78	129.6	130.6	127.48	128.31	4.70	1.50	128.82	0.27	9.67	1.93	130.24	0.61
	23194	116.85	130.6	130.7	127.54	128.37	4.34	1.50	128.81	0.26	8.78	1.76	130.13	no wall
	23444	117.68	130.6	129.2	127.91	128.68	4.25	1.50	129.10	0.26	8.57	1.71	130.39	1.19
	23605	118.21	130.3	129.5	128.12	128.87	4.40	1.50	129.32	0.27	8.32	1.66	130.53	1.03
	23855	119.04	129.1	129.0	128.51	129.20	4.48	1.50	129.67	0.28	6.13	1.23	132.20	3.20
	24105	119.87	129.5	129.5	128.92	129.55	4.35	1.50	129.99	0.28	6.27	1.25	132.55	3.05
	24232	120.29	129.5	129.7	129.17	129.77	3.59	1.20	130.01	0.22	7.62	1.52	132.77	3.27
	24358	120.71	130.0	130.0	129.26	129.85	3.74	1.20	130.11	0.23	8.19	1.64	131.49	1.49
	24462	121.05	131.0	132.0	128.81	129.40	9.62	1.00	130.84	0.59	8.35	1.67	131.07	0.07
Cunningham	24513	121.05	131.0	132.0	129.71	130.65	8.36	1.00	131.74	0.48	9.60	1.92	132.57	1.57

[1] Highest Natural Grade w/in R.O.W. to contain flow.

[2] Walls not allowed between Coyote Creek and Highway 101 (Coyote Creek floodplain).

LOWER SILVER CREEK REACHES 1 THRU 6

HYDRAULIC STABILITY AND SCOUR POTENTIAL FOR PROPOSED CHANNEL IMPROVEMENTS

	Channel Parameters				Design Parameters with Low Roughness							
Location	River Station	Channel Invert	LOB Elev[1]	ROB Elev[1]	1% WSEL	1% Chan Velocity	10% Chan Velocity	a	E.G. Elev	Froude Number	Freeboard Line	Energy Grade Contained?
		(NAVD)	(NAVD)	(NAVD)	(NAVD)	(fps)	(fps)		(NAVD)		(NAVD)	
Coyote Creek	73	63.70	84.0	74.0	67.53	18.68	17.84	1.20	74.03	2.33	87.75	YES
	104	64.00	84.0	75.0	69.58	15.95	15.49	1.20	74.32	1.52	87.75	YES
	106	65.00	84.0	75.0	70.44	14.31	13.83	1.20	74.26	1.34	87.75	YES
	200	65.37	85.0	76.0	72.23	11.31	10.72	1.20	74.61	1.00	87.74	YES
	400	66.14	83.2	82.0	72.88	11.66	10.37	1.20	75.41	1.05	87.74	YES
	500	66.53	84.7	82.5	72.65	13.85	11.94	1.20	76.22	1.34	87.74	YES
	600	66.92	85.6	84.2	73.45	13.57	12.72	1.20	76.88	1.24	87.74	YES
	700	67.31	86.8	85.0	74.63	11.93	11.31	1.20	77.28	1.00	86.87	YES
	830	67.82	88.0	86.0	75.44	10.94	10.35	1.20	77.67	0.90	86.53	YES
	860	67.93	88.0	86.1	76.03	9.49	9.39	1.20	77.71	0.78	86.86	YES
	930	68.21	88.0	86.2	76.11	9.88	9.51	1.20	77.93	0.78	87.16	YES
	1025	68.21	89.7	88.5	74.01	17.74	17.06	1.20	79.87	1.53	87.43	YES
	1067	68.74	89.9	90.4	75.68	15.38	14.54	1.20	80.09	1.29	87.30	YES
Wooster	1107	68.90	89.9	90.4	77.90	10.43	9.82	1.20	79.93	0.73	87.46	YES
	1120	68.95	90.0	90.5	77.93	10.47	9.86	1.20	79.97	0.73	87.45	YES
	1148	69.06	86.9	88.5	78.63	8.42	7.99	1.20	79.95	0.57	87.41	YES
	1253	69.47	89.0	88.0	74.92	20.07	18.64	1.20	82.43	1.79	87.36	YES
	1273	69.55	89.1	88.1	74.87	20.79	19.41	1.20	82.92	1.89	87.35	YES
	1350	69.85	88.0	88.4	75.84	20.77	19.89	1.20	83.88	1.70	87.12	YES
	1390	70.00	89.5	89.7	77.29	19.44	18.88	1.20	84.33	1.38	87.15	YES
UPRR	1410	70.08	89.9	89.6	81.76	10.31	9.78	1.20	83.74	0.62	87.35	YES
	1450	70.24	89.9	89.6	81.81	10.35	9.83	1.20	83.81	0.62	87.37	YES
	1525	70.53	89.2	85.0	83.14	6.62	6.35	1.20	83.96	0.39	88.39	YES
	1622	70.91	88.5	85.4	83.31	6.07	5.88	1.20	84.00	0.36	88.46	YES
	1667	71.08	89.6	87.0	83.22	6.86	6.66	1.20	84.10	0.41	87.49	YES
	1763	71.46	89.6	87.0	83.23	7.16	6.99	1.20	84.19	0.44	87.48	YES
	1845	71.78	88.0	87.0	83.26	7.23	6.84	1.20	84.23	0.41	87.77	YES
	1884	71.92	87.8	88.4	82.99	9.52	9.00	1.20	84.68	0.55	87.57	YES
	1885	71.92	87.8	88.4	82.99	9.52	9.00	1.20	84.68	0.55	87.57	YES
Highway 101	2045	72.32	90.1	90.1	83.52	9.39	8.89	1.20	85.16	0.54	88.06	YES
	2046	72.32	90.2	90.2	83.53	9.39	8.88	1.20	85.17	0.54	88.07	YES
	2075	72.42	88.8	90.0	83.88	8.45	8.11	1.20	85.21	0.49	88.22	YES
	2120	72.47	87.2	89.5	84.66	5.16	4.93	1.20	85.16	0.27	89.18	YES
	2220	72.58	86.6	89.6	84.81	4.42	4.24	1.20	85.17	0.24	89.75	YES
	2280	72.65	86.6	89.8	84.76	4.99	4.79	1.20	85.22	0.27	89.74	YES
	2525	72.93	87.8	87.8	84.81	5.10	4.91	1.20	85.29	0.28	89.33	YES
	2625	73.04	88.1	87.6	84.86	4.94	4.78	1.20	85.31	0.28	89.30	YES
	2775	73.21	88.6	88.0	84.99	4.28	4.25	1.20	85.33	0.26	89.11	YES
	3000	73.47	88.0	87.8	85.05	4.18	4.19	1.20	85.38	0.26	89.19	YES
	3200	73.69	88.2	88.8	85.08	4.43	4.42	1.20	85.45	0.27	89.33	YES
	3282	73.78	88.3	88.9	85.10	4.47	4.46	1.20	85.47	0.28	89.36	YES
	3300	73.80	88.0	88.5	85.10	4.56	4.51	1.20	85.49	0.28	89.46	YES
	3500	74.02	88.2	88.0	85.14	4.64	4.61	1.20	85.54	0.28	89.56	YES
	3626	74.16	88.3	88.1	85.17	4.71	4.67	1.20	85.58	0.29	89.62	YES
	3671	74.21	88.0	88.2	85.23	4.34	4.27	1.20	85.58	0.26	89.78	YES
	3771	74.32	88.0	88.3	85.19	4.98	4.88	1.20	85.65	0.29	89.78	YES
Miguelita Creek	3828	74.38	88.2	88.6	84.36	10.70	10.19	1.00	86.14	0.60	89.92	YES
	4100	74.65	89.0	89.0	85.03	9.01	8.94	1.00	86.29	0.49	90.40	YES
	4300	74.85	89.0	89.0	85.08	9.11	9.04	1.00	86.37	0.50	90.47	YES
	4500	75.05	89.0	89.0	85.12	9.21	9.15	1.00	86.44	0.51	90.53	YES
	4700	75.25	89.0	89.0	85.16	9.31	9.26	1.00	86.51	0.52	90.60	YES
	4900	75.45	89.0	89.0	85.20	9.42	9.37	1.00	86.58	0.52	90.66	YES
	5030	75.58	89.5	89.5	85.24	9.47	9.42	1.00	86.63	0.53	90.72	YES
Walgreens	5070	75.62	89.6	90.0	85.24	9.50	9.46	1.00	86.64	0.53	90.74	YES
	5100	75.65	89.6	92.0	85.24	9.52	9.47	1.00	86.65	0.53	90.75	YES
	5105	75.65	89.0	92.0	85.15	9.96	9.99	1.00	86.69	0.57	90.65	YES
	5174	75.77	90.2	92.0	85.17	10.04	10.09	1.00	86.74	0.58	90.66	YES
	5240	75.96	90.4	92.0	85.15	10.37	10.51	1.00	86.82	0.61	90.62	YES
McKee	5428	76.35	90.0	90.0	86.68	10.23	10.15	1.20	88.63	0.60	94.28	YES
	5490	76.47	90.0	91.0	88.29	5.07	5.06	1.20	88.77	0.30	95.11	YES
	5527	76.53	90.5	91.5	88.28	5.39	5.50	1.20	88.82	0.35	95.13	YES
	5660	76.78	90.7	92.2	88.41	4.86	4.93	1.20	88.85	0.31	94.25	YES
	5900	77.23	90.0	92.6	88.46	5.15	5.25	1.20	88.95	0.34	94.39	YES
	6028	77.47	91.5	92.8	88.56	4.88	5.22	1.20	89.00	0.34	94.55	YES
	6116	77.64	91.7	91.7	88.59	5.01	5.48	1.20	89.06	0.32	92.63	YES

LOWER SILVER CREEK REACHES 1 THRU 6

HYDRAULIC STABILITY AND SCOUR POTENTIAL FOR PROPOSED CHANNEL IMPROVEMENTS

	Channel Parameters				Design Parameters with Low Roughness							
Location	River Station	Channel Invert	LOB Elev[1]	ROB Elev[1]	1% WSEL	1% Chan Velocity	10% Chan Velocity	a	E.G. Elev	Froude Number	Freeboard Line	Energy Grade Contained?
		(NAVD)	(NAVD)	(NAVD)	(NAVD)	(fps)	(fps)		(NAVD)		(NAVD)	
	6200	77.80	91.2	92.5	88.62	4.99	5.34	1.20	89.08	0.31	94.60	YES
	6437	78.24	92.1	92.1	88.60	5.83	5.99	1.20	89.23	0.38	93.05	YES
	6657	78.65	93.1	92.9	88.67	6.12	6.29	1.20	89.37	0.41	93.56	YES
	6723	78.78	92.5	92.5	88.68	6.34	6.50	1.20	89.43	0.43	93.62	YES
	6823	78.96	92.0	92.3	88.52	7.64	7.68	1.20	89.61	0.49	93.75	YES
	6880	79.07	92.0	92.0	88.30	8.91	8.81	1.00	89.53	0.54	93.96	YES
	7128	79.54	92.7	92.3	88.33	9.29	9.24	1.00	89.67	0.58	93.97	YES
	7428	80.11	94.0	92.5	88.35	9.81	9.82	1.00	89.84	0.63	93.98	YES
	7600	80.44	93.5	93.0	88.37	10.12	10.17	1.00	89.96	0.66	94.01	YES
	7800	80.82	93.0	93.0	88.39	10.53	10.65	1.00	90.11	0.70	94.02	YES
	8040	81.27	94.0	93.5	88.41	11.14	11.35	1.00	90.34	0.76	94.03	YES
	8128	81.44	94.0	93.0	88.42	11.39	14.30	1.00	90.43	0.78	94.05	YES
	8300	81.77	94.0	95.7	88.42	11.99	14.19	1.00	90.65	0.85	94.06	YES
	8500	82.15	95.0	96.2	87.65	14.69	14.06	1.00	91.00	1.15	94.08	YES
	8700	82.53	95.6	97.2	88.16	14.32	13.72	1.00	91.34	1.10	94.11	YES
	8756	82.63	96.1	97.2	88.67	13.40	12.80	1.00	91.46	1.00	94.10	YES
	8763	82.65	98.0	98.0	89.36	11.95	11.36	1.00	91.58	0.84	94.17	YES
Alum Rock	8863	82.84	96.5	97.0	88.23	15.14	15.00	1.00	91.79	1.20	94.36	YES
	8908	82.94	96.0	96.5	89.53	12.51	12.00	1.20	92.45	1.00	94.24	YES
	8908	82.94	96.0	96.5	90.27	10.81	10.43	1.20	92.45	0.83	94.34	YES
	9100	83.61	96.6	96.6	90.66	11.41	11.03	1.20	93.09	0.89	95.08	YES
	9230	84.06	97.1	97.1	89.34	16.98	16.74	1.20	94.71	1.55	95.53	YES
	9325	84.39	97.5	97.5	90.57	16.67	16.39	1.20	95.75	1.56	95.81	YES
	9337	84.43	97.5	97.5	92.71	12.44	11.93	1.20	95.59	1.00	96.18	YES
	9387	84.60	98.0	98.0	95.29	7.28	6.69	1.20	96.28	0.39	97.30	YES
Sunset	9498	84.83	98.0	98.0	95.90	7.03	6.52	1.20	96.82	0.37	97.99	YES
	9559	85.07	98.1	98.1	96.01	6.67	6.39	1.20	96.84	0.42	97.52	YES
	9572	85.12	98.1	98.1	96.11	6.23	5.98	1.20	96.83	0.39	97.65	YES
	9800	86.08	99.1	99.1	96.14	7.04	6.80	1.20	97.06	0.46	98.20	YES
	10000	86.92	98.4	99.3	96.17	7.88	7.69	1.20	97.33	0.53	98.77	YES
	10200	87.76	100.8	100.8	96.21	8.90	8.76	1.20	97.69	0.63	99.42	YES
	10300	88.17	100.7	101.2	96.25	9.45	9.34	1.20	97.91	0.68	99.76	YES
	10349	88.31	100.8	101.3	96.58	8.50	8.19	1.20	97.93	0.58	99.99	YES
	10446	88.58	101.0	102.0	96.15	11.59	10.93	1.20	98.65	0.74	100.10	YES
San Antonio	10556	88.88	102.0	101.2	96.55	11.44	10.80	1.20	98.99	0.73	100.45	YES
	10630	89.08	101.3	101.0	96.82	11.00	11.29	1.20	99.07	0.82	100.57	YES
	10671	89.19	101.4	101.1	98.41	6.66	6.49	1.20	99.24	0.46	101.33	YES
	10884	89.79	101.0	101.5	98.68	6.24	6.16	1.20	99.41	0.45	101.78	YES
	11100	90.39	101.5	105.0	98.76	6.83	6.78	1.20	99.63	0.51	101.86	YES
	11300	90.94	102.3	103.0	98.87	7.43	7.40	1.20	99.90	0.58	102.41	YES
	11519	91.54	104.0	104.2	99.05	8.09	8.05	1.20	100.27	0.65	102.81	YES
	11733	92.13	103.5	105.5	99.73	6.34	6.25	1.20	100.48	0.51	103.34	YES
	11800	92.32	102.3	104.3	99.76	6.56	6.47	1.20	100.56	0.54	103.40	YES
	11900	92.59	102.6	104.6	99.83	6.86	6.78	1.20	100.71	0.57	103.52	YES
	12100	93.15	103.4	104.0	100.00	7.50	7.42	1.20	101.05	0.65	103.79	YES
	12250	93.56	103.8	104.0	100.18	7.94	7.83	1.20	101.35	0.70	104.02	YES
	12350	93.84	104.0	104.0	100.79	6.82	6.49	1.20	101.66	0.56	104.56	YES
(Hydraulic Jump	12450	94.12	104.0	104.0	98.38	18.59	17.39	1.20	104.82	2.16	104.58	NO
	12500	94.26	108.0	110.0	100.82	14.59	13.95	1.20	104.79	1.00	104.85	YES
I680	12794	94.15	110.0	110.0	105.05	8.78	8.36	1.00	106.25	0.47	107.39	YES
	12795	94.15	110.0	110.0	105.05	8.78	8.36	1.00	106.25	0.47	107.39	YES
	12829	94.20	108.2	106.3	105.25	8.10	7.72	1.00	106.27	0.43	107.64	YES
	12880	94.34	107.3	105.8	105.99	4.79	4.60	1.00	106.35	0.25	110.13	YES
	13013	94.72	107.5	106.7	105.98	4.97	4.79	1.00	106.36	0.27	108.29	YES
	13035	94.78	107.5	106.7	105.92	5.48	5.25	1.00	106.39	0.29	108.35	YES
Jackson	13125	95.05	107.5	106.7	106.63	5.27	5.15	1.20	107.15	0.27	110.82	YES
	13126	95.05	107.5	106.7	106.62	5.38	5.26	1.20	107.16	0.28	110.81	YES
	13210	95.30	107.2	106.2	106.69	5.15	5.16	1.20	107.18	0.28	110.95	YES
	13300	95.57	107.2	106.3	106.70	5.28	5.31	1.20	107.22	0.30	110.04	YES
	13400	95.87	106.9	107.0	106.71	5.44	5.49	1.20	107.26	0.31	110.14	YES
	13500	96.17	107.8	107.6	106.72	5.61	5.68	1.20	107.31	0.32	109.21	YES
	13600	96.47	107.8	107.7	106.73	5.79	5.89	1.20	107.35	0.34	109.29	YES
	13700	96.77	108.3	108.2	106.75	5.98	6.11	1.20	107.42	0.36	109.38	YES
	13800	96.77	109.3	109.0	106.80	5.95	6.05	1.20	107.46	0.35	109.56	YES
	13900	97.07	109.9	108.5	106.82	6.14	6.27	1.20	107.52	0.37	109.67	YES

LOWER SILVER CREEK REACHES 1 THRU 6

HYDRAULIC STABILITY AND SCOUR POTENTIAL FOR PROPOSED CHANNEL IMPROVEMENTS

	Channel Parameters				Design Parameters with Low Roughness							
Location	River Station	Channel Invert (NAVD)	LOB Elev[1] (NAVD)	ROB Elev[1] (NAVD)	1% WSEL (NAVD)	1% Chan Velocity (fps)	10% Chan Velocity (fps)	a	E.G. Elev (NAVD)	Froude Number	Freeboard Line (NAVD)	Energy Grade Contained?
	14000	97.67	109.7	108.5	106.81	6.61	6.84	1.20	107.62	0.41	109.70	YES
	14100	97.97	110.9	109.9	106.84	6.84	7.10	1.20	107.71	0.43	109.83	YES
	14200	98.27	111.1	111.2	106.87	7.08	7.39	1.20	107.80	0.46	109.96	YES
	14300	98.57	109.9	110.8	106.90	7.34	7.69	1.20	107.90	0.48	110.11	YES
	14400	98.87	110.2	110.9	106.94	7.61	8.00	1.20	108.02	0.51	110.27	YES
	14500	99.17	110.8	110.8	106.99	7.90	8.32	1.20	108.15	0.54	110.44	YES
	14600	99.47	110.9	111.3	107.05	8.19	8.64	1.20	108.30	0.57	110.62	YES
	14700	99.77	111.4	111.3	107.12	8.50	8.94	1.20	108.47	0.60	110.80	YES
	14800	100.07	111.9	112.2	107.19	8.81	9.24	1.20	108.64	0.63	111.00	YES
	14900	100.37	112.4	111.9	107.28	9.12	9.50	1.20	108.83	0.66	111.21	YES
	15000	100.67	113.1	112.5	107.40	9.41	9.75	1.20	109.05	0.69	111.43	YES
	15100	100.97	114.1	112.8	107.53	9.70	9.93	1.20	109.28	0.73	111.65	YES
	15200	101.27	114.1	114.1	107.68	9.97	10.09	1.20	109.53	0.76	111.88	YES
	15300	101.57	115.5	115.3	107.85	10.21	10.22	1.20	109.79	0.78	112.11	YES
	15380	101.81	116.8	116.8	106.03	16.71	15.69	1.20	111.23	1.63	112.32	YES
	15469	102.08	117.2	114.8	108.05	13.93	13.33	1.20	111.67	1.00	112.40	YES
	15470	102.08	117.2	114.8	108.08	13.87	11.33	1.20	111.66	1.00	112.41	YES
Capitol	15668	103.30	115.5	115.5	111.57	10.06	9.65	1.20	113.46	0.62	113.85	YES
	15669	103.30	115.5	115.5	111.58	10.04	9.65	1.20	113.46	0.62	113.86	YES
	15761	103.60	117.0	117.3	111.25	13.92	13.36	1.20	114.86	1.00	115.32	YES
	15800	103.73	117.0	117.3	111.86	12.87	12.28	1.20	114.95	0.89	115.57	YES
	15900	104.06	117.7	117.8	112.26	12.74	12.16	1.20	115.28	0.88	116.20	YES
	16000	104.38	117.5	117.6	112.65	12.61	12.04	1.20	115.61	0.87	116.74	YES
	16100	104.70	117.8	117.1	112.99	12.56	12.00	1.20	115.93	0.86	117.23	YES
	16200	105.03	118.3	117.3	113.30	12.60	12.03	1.20	116.26	0.87	117.73	YES
	16300	105.35	118.8	117.7	113.62	12.61	12.03	1.20	116.58	0.87	118.25	YES
	16400	105.68	119.1	118.1	113.93	12.65	12.06	1.20	116.91	0.87	118.74	YES
	16500	106.00	118.9	118.4	114.24	12.67	12.07	1.20	117.23	0.87	119.21	YES
	16600	106.33	118.9	118.3	114.55	12.70	12.10	1.20	117.56	0.88	119.63	YES
	16700	106.65	119.2	118.2	114.86	12.72	12.10	1.20	117.87	0.88	119.89	YES
	16800	106.98	119.9	119.1	115.17	12.75	12.13	1.20	118.20	0.88	120.47	YES
	16900	107.32	120.8	119.1	115.49	12.81	12.18	1.20	118.55	0.89	120.87	YES
	17000	107.67	122.3	120.0	115.80	12.89	12.25	1.20	118.90	0.89	121.25	YES
N Babb	17050	107.76	121.0	122.9	116.20	12.31	11.70	1.20	119.02	0.83	121.48	YES
	17125	108.03	121.0	121.0	117.73	8.36	8.35	1.20	119.03	0.52	122.25	YES
Granite Creek	17200	108.18	122.6	120.4	117.82	8.43	8.40	1.20	119.14	0.53	122.42	YES
	17450	108.68	122.8	121.3	118.09	8.68	8.64	1.20	119.49	0.55	122.96	YES
	17700	109.19	123.2	121.7	118.37	8.93	8.85	1.20	119.86	0.57	123.49	YES
	17863	109.51	123.8	121.4	118.57	9.08	8.99	1.20	120.11	0.59	124.75	YES
	18025	109.84	123.8	122.0	118.79	9.22	9.11	1.20	120.37	0.60	126.08	YES
	18193	110.18	124.1	122.3	119.03	9.34	9.21	1.20	120.66	0.61	126.42	YES
	18205	110.20	122.0	125.0	119.08	9.26	9.02	1.20	120.68	0.58	126.41	YES
Story	18310	110.41	122.5	125.5	120.62	8.16	7.92	1.20	121.86	0.48	127.16	YES
	18328	110.45	126.9	126.0	121.23	5.60	5.43	1.20	121.81	0.32	125.81	YES
	18523	110.84	126.2	125.6	121.28	5.81	5.65	1.20	121.91	0.34	125.93	YES
	18718	111.23	125.7	125.1	121.35	6.02	5.87	1.20	122.03	0.36	126.05	YES
	18913	111.62	126.9	125.0	121.42	6.25	6.11	1.20	122.15	0.38	126.19	YES
	19108	112.02	126.9	125.3	121.50	6.49	6.36	1.20	122.28	0.40	126.34	YES
	19308	112.42	127.4	125.8	121.59	6.75	6.63	1.20	122.44	0.42	126.51	YES
	19508	112.82	127.2	127.2	121.69	7.01	6.90	1.20	122.61	0.45	126.70	YES
	19708	113.22	128.1	127.7	121.81	7.28	7.18	1.20	122.80	0.47	126.90	YES
	19908	113.62	128.6	128.9	121.95	7.55	7.44	1.20	123.01	0.50	127.11	YES
	19931	113.67	127.0	128.0	121.71	9.50	9.37	1.20	123.39	0.64	126.93	YES
Murtha	19981	113.77	127.0	128.0	121.72	9.63	9.51	1.20	123.45	0.65	127.40	YES
	19983	113.77	127.7	128.5	122.41	7.23	7.11	1.20	123.38	0.47	127.71	YES
	20168	113.95	129.7	129.0	122.57	7.25	7.11	1.20	123.55	0.47	127.94	YES
	20418	114.2	129.0	128.9	123.15	5.31	5.46	1.20	123.68	0.34	128.38	YES
	20668	114.45	128.7	129.7	123.25	5.42	5.57	1.20	123.80	0.35	128.52	YES
	20918	114.7	129.6	129.7	123.36	5.52	5.67	1.20	123.93	0.36	128.66	YES
	21168	114.94	129.4	128.9	123.48	5.61	5.75	1.20	124.07	0.37	128.81	YES
	21396	115.17	132.0	129.8	123.6	5.70	5.83	1.20	124.21	0.37	128.97	YES
	21665	115.44	132.4	130.0	123.73	5.81	5.93	1.20	124.36	0.39	129.13	YES
	21719	115.49	128.4	128.4	123.33	9.43	9.56	1.20	124.99	0.59	129.18	YES
Moss Point	21780	115.54	128.4	128.4	124.77	8.01	7.96	1.20	125.97	0.46	129.84	YES
	21820	115.58	131.0	131.8	125.68	3.47	3.45	1.20	125.90	0.20	130.25	YES

LOWER SILVER CREEK REACHES 1 THRU 6

HYDRAULIC STABILITY AND SCOUR POTENTIAL FOR PROPOSED CHANNEL IMPROVEMENTS

	Channel Parameters				Design Parameters with Low Roughness							
Location	River Station	Channel Invert	LOB Elev[1]	ROB Elev[1]	1% WSEL	1% Chan Velocity	10% Chan Velocity	a	E.G. Elev	Froude Number	Freeboard Line	Energy Grade Contained?
		(NAVD)	(NAVD)	(NAVD)	(NAVD)	(fps)	(fps)		(NAVD)		(NAVD)	
	22070	115.8	130.7	131.2	125.71	3.54	3.53	1.20	125.94	0.21	130.30	YES
	22320	116.03	132.0	130.2	125.74	3.62	3.62	1.20	125.98	0.22	130.35	YES
	22570	116.25	131.8	129.2	125.77	3.70	3.70	1.20	126.03	0.22	130.39	YES
	22820	116.48	131.6	131.2	125.8	3.79	3.79	1.20	126.07	0.23	130.44	YES
	23009	116.65	131.9	129.8	125.84	3.86	3.86	1.20	126.12	0.24	130.49	YES
	23091	116.72	131.0	131.6	125.65	6.43	6.47	1.20	126.42	0.43	130.23	YES
Ocala	23173	116.78	129.6	130.6	125.66	6.47	6.51	1.20	126.44	0.42	130.24	YES
	23194	116.85	130.6	130.7	125.75	6.08	6.17	1.20	126.44	0.41	130.13	YES
	23444	117.68	130.6	129.2	125.9	6.18	6.28	1.20	126.61	0.43	130.39	YES
	23605	118.21	130.3	129.5	125.97	6.60	6.73	1.20	126.78	0.47	130.53	YES
	23855	119.04	129.1	129.0	126.14	7.05	7.20	1.20	127.07	0.53	132.20	YES
	24105	119.87	129.5	129.5	126.41	7.10	7.24	1.20	127.35	0.55	132.55	YES
	24232	120.29	129.5	129.7	126.87	5.42	5.45	1.20	127.42	0.4	132.77	YES
	24358	120.71	130.0	130.0	126.91	5.8	5.86	1.20	127.54	0.44	131.49	YES
	24462	121.05	131.0	132.0	126.89	13.74	13.45	1.20	130.41	1	131.12	YES
Cunningham	24513	121.05	131.0	132.0	129.87	9.1	9.55	1.20	131.41	0.54	132.57	YES

[1] Highest Natural Grade w/in R.O.W. to contain flow.

[2] Walls not allowed between Coyote Creek and Highway 101 (Coyote Creek floodplain).

COYOTE WATERSHED PROGRAM
LOWER SILVER CREEK IMPROVEMENTS
TRACTIVE FORCE ANALYSIS

Reach:	Coyote Creek to Highway 101	Highway 101 to Reach 2	Reach 3A	Reach 3D	Reach 3E&F	Reach 4B	Reach 4C	Reach 5	Reach 6A	Reach 6B
d_{90} (mm)	1.5	2.60	0.01	0.03	0.2	0.6	0.6	0.3	0.4	0.4
2-year Q	940	940	810	780	780	780	780	680	610	610
T.W.	52	50	48	38	38	49	21	21	21	56
q	18.1	18.8	16.9	20.5	20.5	15.9	37.1	32.4	29.0	10.9
n	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
depth	3.5	3.6	3.5	3.3	4.0	3.0	3.8	4	3.5	2.75
S_{EG}	0.0040	0.0007	0.0015	0.0035	0.0025	0.0030	0.0032	0.002	0.0009	0.0025
U_*	0.67	0.28	0.41	0.61	0.57	0.54	0.63	0.51	0.32	0.47
R_*	330	243	1	6	37	106	123	50	42	62
K_s	0.058	0.056	0.12	0.035	0.037	0.046	0.047	0.04	0.038	0.041
S_{eq}	5.9337E-05	1.1973E-04	1.3846E-07	9.6728E-08	1.5741E-06	1.2834E-05	6.4017E-06	2.1246E-06	3.2687E-06	8.4456E-06
$S_{initial}$	0.0039	0.0011	0.0019	0.0035	0.0028	0.003	0.0033	0.002	0.001	0.0033
Max. Unprotected L	1800	1675	1450	800	1150	2350	1380	1600	1700	1300
Max Degredation	6.9	1.6	2.8	2.8	3.2	7.0	4.5	3.2	1.7	4.3
Spacing for 3' Deg.	781	N/A	N/A	N/A	1072	1004	911	1502	3010	911
			Total Degradation at 680 is 2.8' + 3.2' = 5.0'							
						Total Degradation at Moss Point is 3.2' + 1.7' = 4.9'				
							Total Degradation at Cunningham is 1.4' + 4.3' = 5.7'			

LOWER SILVER CREEK REACHES 1 THRU 6

RELATIVE SEDIMENT TRANSPORT CAPACITY AND TRACTIVE FORCE ANALYSIS

		Transport Capacity				Low Roughness			High Roughness				
Location	River Station	1% Velocity w/ Low Roughness (fps)	Stream Power w/ Low Roughness (lb/ft-sec)	1% Velocity w/ High Roughness (fps)	Stream Power w/ High Roughness (lb/ft-sec)	Unit Tractive Force (lb/ft^2)	Tractive Force on Bed (lb/ft^2)	Tractive Force on Banks (lb/ft^2)	Unit Tractive Force (lb/ft^2)	Tractive Force on Bed (lb/ft^2)	Tractive Force on Banks (lb/ft^2)	Permissible Tractive Force (lb/ft^2)	Hard Bank Protection
Coyote Creek	73	18.68	58.78	1.53	0.09	3.15	3.06	2.36	0.06	0.06	0.05	0.14	No
	104	15.95	30.78	2.01	0.20	1.93	1.87	1.45	0.10	0.10	0.08	0.14	No
	106	14.31	21.94	2.04	0.21	1.53	1.48	1.15	0.10	0.10	0.08	0.14	No
	200	11.31	10.43	2.76	0.52	0.92	0.89	0.69	0.19	0.18	0.14	0.14	No
	400	11.66	11.54	2.93	0.63	0.99	0.96	0.74	0.22	0.21	0.17	0.14	No
	500	13.85	20.31	3.01	0.70	1.47	1.43	1.10	0.23	0.22	0.17	0.14	No
	600	13.57	18.43	3.46	1.07	1.36	1.32	1.02	0.31	0.30	0.23	0.14	No
	700	11.93	11.86	3.82	1.47	0.99	0.96	0.74	0.38	0.37	0.29	0.14	No
	830	10.94	8.98	3.87	1.54	0.82	0.80	0.62	0.40	0.39	0.30	0.14	No
	860	9.49	5.88	3.65	1.28	0.62	0.60	0.47	0.35	0.34	0.26	0.14	Yes
	930	9.88	6.49	3.91	1.59	0.66	0.64	0.50	0.41	0.40	0.31	0.14	Yes
	1025	17.74	40.02	4.61	2.61	2.26	2.19	1.70	0.57	0.55	0.43	0.14	Yes
	1067	15.38	25.78	5.66	4.95	1.68	1.63	1.26	0.87	0.84	0.65	0.14	Yes
Wooster	1107	10.43	7.19	5.65	4.90	0.69	0.67	0.52	0.87	0.84	0.65	0.14	Yes
	1120	10.47	7.28	5.66	4.95	0.7	0.68	0.53	0.87	0.84	0.65	0.14	Yes
	1148	8.42	3.68	4.87	3.13	0.44	0.43	0.33	0.64	0.62	0.48	0.14	Yes
	1253	20.07	59.11	4.37	2.29	2.95	2.86	2.21	0.52	0.50	0.39	0.14	Yes
	1273	20.79	66.36	4.40	2.34	3.19	3.09	2.39	0.53	0.51	0.40	0.14	Yes
	1350	20.77	62.05	7.17	10.24	2.99	2.90	2.24	1.43	1.39	1.07	0.14	Yes
	1390	19.44	47.75	8.82	19.60	2.46	2.39	1.85	2.22	2.15	1.67	0.14	Yes
UPRR	1410	10.31	6.40	8.11	14.99	0.62	0.60	0.47	1.85	1.79	1.39	0.14	Yes
	1450	10.35	6.48	8.05	14.63	0.63	0.61	0.47	1.82	1.77	1.37	0.14	Yes
	1525	6.62	1.64	5.46	4.42	0.25	0.24	0.19	0.81	0.79	0.61	0.14	Yes
	1622	6.07	1.28	4.93	3.29	0.21	0.20	0.16	0.67	0.65	0.50	0.14	Yes
	1667	6.86	1.85	5.49	4.56	0.27	0.26	0.20	0.83	0.81	0.62	0.14	Yes
	1763	7.16	2.13	5.62	4.93	0.3	0.29	0.23	0.88	0.85	0.66	0.14	Yes
	1845	7.23	2.09	5.82	5.26	0.29	0.28	0.22	0.90	0.87	0.68	0.14	Yes
	1884	9.52	4.89	7.42	11.38	0.51	0.49	0.38	1.53	1.48	1.15	0.14	Yes
	1885	9.52	1.48	7.42	1.82	0.16	0.16	0.12	0.25	0.24	0.19	concrete	Yes
Highway 101	2045	9.39	1.42	7.41	1.80	0.15	0.15	0.11	0.24	0.23	0.18	concrete	Yes
	2046	9.39	1.42	7.42	1.80	0.15	0.15	0.11	0.24	0.23	0.18	0.14	Yes
	2075	8.45	3.39	6.73	6.56	0.4	0.39	0.30	0.98	0.95	0.74	0.14	Yes
	2120	5.16	0.74	4.38	1.75	0.14	0.14	0.11	0.40	0.39	0.30	0.14	Yes
	2220	4.42	0.47	3.74	1.08	0.11	0.11	0.08	0.29	0.28	0.22	0.15	Yes
	2280	4.99	0.67	4.20	1.53	0.13	0.13	0.10	0.36	0.35	0.27	0.16	Yes
	2525	5.10	0.72	4.26	1.60	0.14	0.14	0.11	0.38	0.37	0.29	0.17	Yes
	2625	4.94	0.66	4.06	1.76	0.13	0.13	0.10	0.43	0.42	0.32	0.18	Yes
	2775	4.28	0.44	3.39	1.05	0.1	0.10	0.08	0.31	0.30	0.23	0.19	No
	3000	4.18	0.42	3.25	0.93	0.1	0.10	0.08	0.29	0.28	0.22	0.19	No
	3200	4.43	0.50	3.44	1.10	0.11	0.11	0.08	0.32	0.31	0.24	0.19	No
	3282	4.47	0.51	3.45	1.12	0.11	0.11	0.08	0.32	0.31	0.24	0.19	No
	3300	4.56	0.53	3.56	1.21	0.12	0.12	0.09	0.34	0.33	0.26	0.19	No
	3500	4.64	0.57	3.59	1.25	0.12	0.12	0.09	0.35	0.34	0.26	0.19	No
	3626	4.71	0.59	3.62	1.27	0.13	0.13	0.10	0.35	0.34	0.26	0.19	No
	3671	4.34	0.46	3.38	1.03	0.11	0.11	0.08	0.30	0.29	0.23	0.19	No
	3771	4.98	0.69	3.86	1.53	0.14	0.14	0.11	0.40	0.39	0.30	0.19	Yes
Miguelita Creek	3828	10.70	2.19	8.25	2.54	0.2	0.19	0.15	0.31	0.30	0.23	concrete	Yes
	4100	9.01	1.30	7.15	1.65	0.14	0.14	0.11	0.23	0.22	0.17	concrete	Yes
	4300	9.11	1.34	7.19	1.68	0.15	0.15	0.11	0.23	0.22	0.17	concrete	Yes
	4500	9.21	1.39	7.23	1.71	0.15	0.15	0.11	0.24	0.23	0.18	concrete	Yes
	4700	9.31	1.44	7.27	1.74	0.16	0.16	0.12	0.24	0.23	0.18	concrete	Yes
	4900	9.42	1.50	7.31	1.78	0.16	0.16	0.12	0.24	0.23	0.18	concrete	Yes
	5030	9.47	1.53	7.33	1.79	0.16	0.16	0.12	0.24	0.23	0.18	concrete	Yes
Walgreens	5070	9.50	1.54	7.34	1.80	0.16	0.16	0.12	0.24	0.23	0.18	concrete	Yes
	5100	9.52	1.55	7.34	1.80	0.16	0.16	0.12	0.24	0.23	0.18	concrete	Yes
	5105	9.96	1.79	7.57	1.98	0.18	0.17	0.14	0.26	0.25	0.20	concrete	Yes
	5174	10.04	1.84	7.60	2.01	0.18	0.17	0.14	0.26	0.25	0.20	concrete	Yes
	5240	10.37	2.04	7.73	2.12	0.2	0.19	0.15	0.27	0.26	0.20	concrete	Yes
McKee	5428	10.23	1.97	7.32	1.80	0.19	0.18	0.14	0.25	0.24	0.19	concrete	Yes
	5490	5.07	0.73	3.79	1.43	0.14	0.14	0.11	0.38	0.37	0.29	0.14	No
	5527	5.39	0.92	3.84	1.56	0.17	0.16	0.13	0.41	0.40	0.31	0.14	No
	5660	4.86	0.66	3.53	1.19	0.14	0.14	0.11	0.34	0.33	0.26	0.15	No
	5900	5.15	0.81	3.48	1.17	0.16	0.16	0.12	0.34	0.33	0.26	0.16	No
	6028	4.88	0.71	2.55	0.46	0.15	0.15	0.11	0.18	0.17	0.14	0.17	No
	6116	5.01	0.73	2.33	0.34	0.15	0.15	0.11	0.15	0.15	0.11	0.18	No
	6200	4.99	0.72	2.79	0.58	0.14	0.14	0.11	0.21	0.20	0.16	0.19	No
	6437	5.83	1.18	3.81	1.51	0.2	0.19	0.15	0.40	0.39	0.30	0.20	No
	6657	6.12	1.39	4.13	1.97	0.23	0.22	0.17	0.48	0.47	0.36	0.20	No
	6723	6.34	1.54	4.26	2.16	0.24	0.23	0.18	0.51	0.49	0.38	0.20	No
	6823	7.64	0.81	5.28	0.66	0.11	0.11	0.08	0.12	0.12	0.09	0.20	No
	6880	8.91	1.29	6.38	1.17	0.15	0.15	0.11	0.18	0.17	0.14	concrete	Yes
	7128	9.29	1.48	6.55	1.27	0.16	0.16	0.12	0.19	0.18	0.14	concrete	Yes
	7428	9.81	1.77	6.76	1.42	0.18	0.17	0.14	0.21	0.20	0.16	concrete	Yes
	7600	10.12	1.97	6.88	1.50	0.19	0.18	0.14	0.22	0.21	0.17	concrete	Yes
	7800	10.53	2.25	7.04	1.62	0.21	0.20	0.16	0.23	0.22	0.17	concrete	Yes
	8040	11.14	2.70	7.26	1.79	0.24	0.23	0.18	0.25	0.24	0.19	concrete	Yes
	8128	11.39	2.90	7.35	1.87	0.25	0.24	0.19	0.25	0.24	0.19	concrete	Yes
	8300	11.99	3.44	7.55	2.04	0.29	0.28	0.22	0.27	0.26	0.20	concrete	Yes
	8500	14.69	6.69	7.78	2.24	0.46	0.45	0.35	0.29	0.28	0.22	concrete	Yes
	8700	14.32	6.15	8.03	2.48	0.43	0.42	0.32	0.31	0.30	0.23	concrete	Yes
	8756	13.40	4.95	8.14	2.60	0.37	0.36	0.28	0.32	0.31	0.24	concrete	Yes
	8763	11.95	3.40	8.10	2.56	0.28	0.27	0.21	0.32	0.31	0.24	concrete	Yes
Alum Rock	8863	15.14	7.39	8.10	2.56	0.49	0.48	0.37	0.32	0.31	0.24	concrete	Yes
	8908	12.51	4.06	7.26	1.87	0.32	0.31	0.24	0.26	0.25	0.20	0.18	Left Only
	8908	10.81	8.44	7.18	11.31	0.78	0.76	0.59	1.57	1.52	1.18	0.18	Left Only
	9100	11.41	10.06	7.12	11.00	0.88	0.85	0.66	1.54	1.49	1.16	0.18	Left Only
	9230	16.98	36.47	7.07	10.86	2.15	2.09	1.61	1.54	1.49	1.16	0.18	Left Only

LOWER SILVER CREEK REACHES 1 THRU 6

RELATIVE SEDIMENT TRANSPORT CAPACITY AND TRACTIVE FORCE ANALYSIS

		Transport Capacity				Low Roughness			High Roughness				
Location	River Station	1% Velocity w/ Low Roughness (fps)	Stream Power w/ Low Roughness (lb/ft-sec)	1% Velocity w/ High Roughness (fps)	Stream Power w/ High Roughness (lb/ft-sec)	Unit Tractive Force (lb/ft^2)	Tractive Force on Bed (lb/ft^2)	Tractive Force on Banks (lb/ft^2)	Unit Tractive Force (lb/ft^2)	Tractive Force on Bed (lb/ft^2)	Tractive Force on Banks (lb/ft^2)	Permissible Tractive Force (lb/ft^2)	Hard Bank Protection
	9325	16.67	34.87	7.75	14.49	2.09	2.03	1.57	1.87	1.81	1.40	0.18	Left Only
	9337	12.44	3.99	9.53	4.50	0.32	0.31	0.24	0.47	0.46	0.35	0.18	Left Only
	9387	7.28	0.67	7.35	1.85	0.09	0.09	0.07	0.25	0.24	0.19	concrete	Yes
Sunset	9498	7.03	0.60	7.10	1.65	0.09	0.09	0.07	0.23	0.22	0.17	concrete	Yes
	9559	6.67	0.53	6.74	1.47	0.08	0.08	0.06	0.22	0.21	0.17	0.18	Left Only
	9572	6.23	1.42	6.28	7.40	0.23	0.22	0.17	1.18	1.14	0.89	0.18	Left Only
	9800	7.04	2.12	6.57	8.55	0.3	0.29	0.23	1.30	1.26	0.98	0.18	Left Only
	10000	7.88	3.02	6.77	9.42	0.38	0.37	0.29	1.39	1.35	1.04	0.17	Left Only
	10200	8.90	4.48	6.93	10.16	0.5	0.49	0.38	1.47	1.43	1.10	0.17	Left Only
	10300	9.45	5.45	6.98	10.43	0.58	0.56	0.44	1.49	1.45	1.12	0.16	Left Only
	10349	8.50	1.16	6.62	1.40	0.14	0.14	0.11	0.21	0.20	0.16	0.15	Yes
	10446	11.59	2.97	9.14	3.68	0.26	0.25	0.20	0.40	0.39	0.30	0.14	Yes
San Antonio	10556	11.44	2.85	9.09	3.62	0.25	0.24	0.19	0.40	0.39	0.30	0.14	Yes
	10630	11.00	8.61	7.64	13.52	0.78	0.76	0.59	1.77	1.72	1.33	0.14	Yes
	10671	6.66	1.82	5.42	4.74	0.27	0.26	0.20	0.87	0.84	0.65	0.14	No
	10884	6.24	1.54	4.83	3.39	0.25	0.24	0.19	0.70	0.68	0.53	0.14	No
	11100	6.83	2.06	5.01	3.79	0.3	0.29	0.23	0.76	0.74	0.57	0.14	No
	11300	7.43	2.72	5.16	4.19	0.37	0.36	0.28	0.81	0.79	0.61	0.14	No
	11519	8.09	3.58	5.29	4.54	0.44	0.43	0.33	0.86	0.83	0.65	0.14	No
	11733	6.34	1.72	4.26	2.37	0.27	0.26	0.20	0.56	0.54	0.42	0.14	No
	11800	6.56	1.92	4.33	2.50	0.29	0.28	0.22	0.58	0.56	0.44	0.14	No
	11900	6.86	2.23	4.42	2.67	0.32	0.31	0.24	0.60	0.58	0.45	0.14	No
	12100	7.50	2.99	4.59	3.03	0.4	0.39	0.30	0.66	0.64	0.50	0.14	No
	12250	7.94	3.61	4.71	3.28	0.45	0.44	0.34	0.70	0.68	0.53	0.14	No
	12350	6.82	2.15	4.47	2.70	0.32	0.31	0.24	0.60	0.58	0.45	0.14	No
	12450	18.59	55.24	5.17	4.27	2.97	2.88	2.23	0.83	0.81	0.62	0.14	No
	12500	14.59	6.20	12.29	9.50	0.42	0.41	0.32	0.77	0.75	0.58	concrete	Yes
I680	12794	8.78	1.19	8.68	3.08	0.14	0.14	0.11	0.35	0.34	0.26	concrete	Yes
	12795	8.78	1.19	8.68	3.80	0.14	0.14	0.11	0.44	0.43	0.33	concrete	Yes
	12829	8.10	0.93	8.00	2.94	0.11	0.11	0.08	0.37	0.36	0.28	concrete	Yes
	12880	4.79	0.18	4.73	0.59	0.04	0.04	0.03	0.12	0.12	0.09	concrete	Yes
	13013	4.97	0.21	4.89	0.65	0.04	0.04	0.03	0.13	0.13	0.10	concrete	Yes
	13035	5.48	0.28	5.39	0.87	0.05	0.05	0.04	0.16	0.16	0.12	concrete	Yes
Jackson	13125	5.27	0.24	5.18	0.76	0.05	0.05	0.04	0.15	0.15	0.11	concrete	Yes
	13126	5.38	0.86	5.29	3.25	0.16	0.16	0.12	0.62	0.60	0.47	0.08	Yes
	13210	5.15	0.76	5.02	2.80	0.15	0.15	0.11	0.56	0.54	0.42	0.08	Yes
	13300	5.28	0.83	5.11	2.97	0.16	0.16	0.12	0.58	0.56	0.44	0.08	Yes
	13400	5.44	0.91	5.21	3.18	0.17	0.16	0.13	0.61	0.59	0.46	0.08	Yes
	13500	5.61	1.01	5.32	3.39	0.18	0.17	0.14	0.64	0.62	0.48	0.08	Yes
	13600	5.79	1.12	5.42	3.61	0.19	0.18	0.14	0.67	0.65	0.50	0.08	Yes
	13700	5.98	1.24	5.52	3.83	0.21	0.20	0.16	0.69	0.67	0.52	0.08	Yes
	13800	5.95	1.22	5.43	3.63	0.21	0.20	0.16	0.67	0.65	0.50	0.08	Yes
	13900	6.14	1.35	5.53	3.84	0.22	0.21	0.17	0.70	0.68	0.53	0.08	Yes
	14000	6.61	1.72	5.82	4.55	0.26	0.25	0.20	0.78	0.76	0.59	0.08	Yes
	14100	6.84	1.93	5.91	4.79	0.28	0.27	0.21	0.81	0.79	0.61	0.08	Yes
	14200	7.08	2.16	6.00	5.04	0.31	0.30	0.23	0.84	0.81	0.63	0.08	Yes
	14300	7.34	2.44	6.10	5.29	0.33	0.32	0.25	0.87	0.84	0.65	0.08	Yes
	14400	7.61	2.74	6.18	5.54	0.36	0.35	0.27	0.90	0.87	0.68	0.08	Yes
	14500	7.90	3.09	6.26	5.78	0.39	0.38	0.29	0.92	0.89	0.69	0.08	Yes
	14600	8.19	3.49	6.34	6.02	0.43	0.42	0.32	0.95	0.92	0.71	0.08	Yes
	14700	8.50	3.93	6.41	6.25	0.46	0.45	0.35	0.97	0.94	0.73	0.08	Yes
	14800	8.81	4.43	6.48	6.46	0.5	0.49	0.38	1.00	0.97	0.75	0.08	Yes
	14900	9.12	4.97	6.54	6.67	0.54	0.52	0.41	1.02	0.99	0.77	0.08	Yes
	15000	9.41	5.51	6.60	6.86	0.58	0.56	0.44	1.04	1.01	0.78	0.08	Yes
	15100	9.70	6.09	6.65	7.04	0.63	0.61	0.47	1.06	1.03	0.80	0.08	Yes
	15200	9.97	6.66	6.70	7.22	0.67	0.65	0.50	1.08	1.05	0.81	0.08	Yes
	15300	10.21	7.20	6.75	7.38	0.71	0.69	0.53	1.09	1.06	0.82	0.08	Yes
	15380	16.71	36.57	6.77	7.48	2.19	2.12	1.64	1.10	1.07	0.83	0.08	Yes
	15469	13.93	18.10	9.85	23.42	1.3	1.26	0.98	2.38	2.31	1.79	0.08	Yes
	15470	13.87	5.40	9.85	4.74	0.39	0.38	0.29	0.48	0.47	0.36	concrete	Yes
Capitol	15668	10.06	1.90	9.84	4.72	0.19	0.18	0.14	0.48	0.47	0.36	concrete	Yes
	15669	10.04	6.23	9.84	23.29	0.62	0.60	0.47	2.37	2.30	1.78	0.08	Yes
	15761	13.92	18.04	12.62	52.35	1.3	1.26	0.98	4.15	4.03	3.11	0.08	Yes
	15800	12.87	13.96	11.12	34.67	1.08	1.05	0.81	3.12	3.03	2.34	0.08	Yes
	15900	12.74	13.51	10.03	24.81	1.06	1.03	0.80	2.47	2.40	1.85	0.08	Yes
	16000	12.61	13.07	9.51	20.86	1.04	1.01	0.78	2.19	2.12	1.64	0.08	Yes
	16100	12.56	12.91	9.19	18.67	1.03	1.00	0.77	2.03	1.97	1.52	0.08	Yes
	16200	12.60	13.02	8.98	17.31	1.03	1.00	0.77	1.93	1.87	1.45	0.08	Yes
	16300	12.61	13.08	8.81	16.25	1.04	1.01	0.78	1.85	1.79	1.39	0.08	Yes
	16400	12.65	13.20	8.68	15.54	1.04	1.01	0.78	1.79	1.74	1.34	0.08	Yes
	16500	12.67	13.25	8.57	14.87	1.05	1.02	0.79	1.74	1.69	1.31	0.08	Yes
	16600	12.70	13.37	8.49	14.44	1.05	1.02	0.79	1.70	1.65	1.28	0.08	Yes
	16700	12.72	13.43	8.41	13.98	1.06	1.03	0.80	1.66	1.61	1.25	0.08	Yes
	16800	12.75	13.55	8.35	13.67	1.06	1.03	0.80	1.64	1.59	1.23	0.08	Yes
	16900	12.81	13.75	8.31	13.47	1.07	1.04	0.80	1.62	1.57	1.22	0.08	Yes
	17000	12.89	14.02	8.29	13.36	1.09	1.06	0.82	1.61	1.56	1.21	0.08	Yes
N Babb	17050	12.31	12.29	8.21	13.25	1	0.97	0.75	1.61	1.56	1.21	0.08	Yes
	17125	8.36	3.65	6.39	6.11	0.44	0.43	0.33	0.96	0.93	0.72	0.07	Yes
Granite Creek	17200	8.43	3.75	6.37	6.07	0.44	0.43	0.33	0.95	0.92	0.71	0.07	Yes
	17450	8.68	4.12	6.35	6.01	0.48	0.47	0.36	0.95	0.92	0.71	0.07	Yes
	17700	8.93	4.52	6.34	5.96	0.51	0.49	0.38	0.94	0.91	0.71	0.07	Yes
	17863	9.08	4.78	6.34	5.95	0.53	0.51	0.40	0.94	0.91	0.71	0.07	Yes
	18025	9.22	5.01	6.34	5.96	0.54	0.52	0.41	0.94	0.91	0.71	0.07	Yes
	18193	9.34	5.23	6.33	5.95	0.56	0.54	0.42	0.94	0.91	0.71	0.07	Yes
	18205	9.26	1.52	6.48	1.27	0.16	0.16	0.12	0.20	0.19	0.15	concrete	Yes
Story	18310	8.16	1.01	6.33	1.18	0.12	0.12	0.09	0.19	0.18	0.14	concrete	Yes
	18328	5.60	1.03	4.50	2.03	0.18	0.17	0.14	0.45	0.44	0.34	0.07	Yes

LOWER SILVER CREEK REACHES 1 THRU 6

RELATIVE SEDIMENT TRANSPORT CAPACITY AND TRACTIVE FORCE ANALYSIS

		Transport Capacity				Low Roughness			High Roughness				
Location	River Station	1% Velocity w/ Low Roughness (fps)	Stream Power w/ Low Roughness (lb/ft-sec)	1% Velocity w/ High Roughness (fps)	Stream Power w/ High Roughness (lb/ft-sec)	Unit Tractive Force (lb/ft^2)	Tractive Force on Bed (lb/ft^2)	Tractive Force on Banks (lb/ft^2)	Unit Tractive Force (lb/ft^2)	Tractive Force on Bed (lb/ft^2)	Tractive Force on Banks (lb/ft^2)	Permissible Tractive Force (lb/ft^2)	Hard Bank Protection
	18523	5.81	1.16	4.59	2.16	0.2	0.19	0.15	0.47	0.46	0.35	0.07	Yes
	18718	6.02	1.31	4.68	2.31	0.22	0.21	0.17	0.49	0.48	0.37	0.07	Yes
	18913	6.25	1.47	4.78	2.46	0.24	0.23	0.18	0.51	0.49	0.38	0.07	Yes
	19108	6.49	1.66	4.87	2.61	0.26	0.25	0.20	0.54	0.52	0.41	0.07	Yes
	19308	6.75	1.89	4.96	2.77	0.28	0.27	0.21	0.56	0.54	0.42	0.07	Yes
	19508	7.01	2.14	5.04	2.93	0.3	0.29	0.23	0.58	0.56	0.44	0.07	Yes
	19708	7.28	2.42	5.13	3.10	0.33	0.32	0.25	0.60	0.58	0.45	0.07	Yes
	19908	7.55	2.72	5.21	3.26	0.36	0.35	0.27	0.63	0.61	0.47	0.07	Yes
	19931	9.50	1.60	6.29	1.14	0.17	0.16	0.13	0.18	0.17	0.14	0.07	Yes
Murtha	19981	9.63	1.67	6.10	1.02	0.17	0.16	0.13	0.17	0.16	0.13	0.07	Yes
	19983	7.23	2.37	5.02	2.88	0.33	0.32	0.25	0.57	0.55	0.43	0.07	Yes
	20168	7.25	2.38	5.00	2.85	0.33	0.32	0.25	0.57	0.55	0.43	0.07	Yes
	20418	5.31	0.93	3.77	1.22	0.17	0.16	0.13	0.32	0.31	0.24	0.07	Yes
	20668	5.42	0.99	3.80	1.25	0.18	0.17	0.14	0.33	0.32	0.25	0.07	Yes
	20918	5.52	1.05	3.84	1.29	0.19	0.18	0.14	0.34	0.33	0.26	0.07	Yes
	21168	5.61	1.11	3.86	1.32	0.2	0.19	0.15	0.34	0.33	0.26	0.07	Yes
	21396	5.70	1.17	3.89	1.35	0.21	0.20	0.16	0.35	0.34	0.26	0.07	Yes
	21665	5.81	1.24	3.92	1.38	0.21	0.20	0.16	0.35	0.34	0.26	0.07	Yes
	21719	9.43	1.45	6.48	1.11	0.15	0.15	0.11	0.17	0.16	0.13	concrete	Yes
Moss Point	21780	8.01	0.84	6.20	0.96	0.1	0.10	0.08	0.15	0.15	0.11	concrete	Yes
	21820	3.47	0.24	2.76	0.46	0.07	0.07	0.05	0.17	0.16	0.13	0.07	Yes
	22070	3.54	0.26	2.79	0.48	0.07	0.07	0.05	0.17	0.16	0.13	0.07	Yes
	22320	3.62	0.28	2.83	0.50	0.08	0.08	0.06	0.18	0.17	0.14	0.07	Yes
	22570	3.70	0.3	2.87	0.52	0.08	0.08	0.06	0.18	0.17	0.14	0.07	Yes
	22820	3.79	0.32	2.91	0.55	0.09	0.09	0.07	0.19	0.18	0.14	0.07	Yes
	23009	3.86	0.34	2.94	0.56	0.09	0.09	0.07	0.19	0.18	0.14	0.07	Yes
	23091	6.43	0.49	4.68	0.46	0.08	0.08	0.06	0.10	0.10	0.08	0.07	Yes
Ocala	23173	6.47	0.49	4.70	0.46	0.08	0.08	0.06	0.10	0.10	0.08	0.07	Yes
	23194	6.08	1.41	4.34	2.41	0.23	0.22	0.17	0.55	0.53	0.41	0.07	Yes
	23444	6.18	1.5	4.25	2.27	0.24	0.23	0.18	0.53	0.51	0.40	0.07	Left Only
	23605	6.60	1.86	4.40	2.53	0.28	0.27	0.21	0.58	0.56	0.44	0.07	Left Only
	23855	7.05	2.32	4.48	2.69	0.33	0.32	0.25	0.60	0.58	0.45	0.07	Left Only
	24105	7.10	2.41	4.35	2.49	0.34	0.33	0.26	0.57	0.55	0.43	0.07	Left Only
	24232	5.42	1.05	3.59	1.09	0.19	0.18	0.14	0.30	0.29	0.23	0.07	Left Only
	24358	5.80	1.32	3.74	1.24	0.23	0.22	0.17	0.33	0.32	0.25	0.07	Yes
	24462	13.74	16.28	9.62	19.84	1.18	1.14	0.89	2.06	2.00	1.55	concrete	Yes
Cunningham	24513	9.10	4.12	8.36	12.43	0.45	0.44	0.34	1.49	1.45	1.12	concrete	Yes